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Realizing the Ideal

NICHOLAS MURRAY BUTLER wrote, "The best is often the enemy of the good."

Some of us are so insistent upon having and doing the best from the start that we never get started.

Few things spring out of chaos perfected and full-fledged. They have to go through a process of evolution. If the electric-light industry had waited for the invention of the steam turbine and tungsten lamp, many other things would still be undeveloped.

The carbon filament was the best thing that Edison could think of or find, and it did a good job and set the industry to going while something better was being worked out.

Do not let anything that I say here be taken as an admission that one should not do his best all the time.

But do not hold up the procession while you try to realize perfection.

It is often difficult to decide how much time to devote to polishing up the little details that collectively make a perfect job, to know how far to pursue the hope of doing better when you can easily and quickly do well.

It requires a sense of perspective and proportion, an appreciation of the main object and its value, the extent to which the best attainment of that object will be affected by further puttering or advanced by giving it a start and a chance for development through adaptation; and it requires the ability to sacrifice personal interest in details to the good of the general project.

Do your best all the time. Never send out a faulty job or project that you could make enough better to pay for the delay and expense. But remember, "The best is often the enemy of the good," and do not sacrifice progress and utility to a hope of the immediate realization of an ideal. Give the Good a start and it may develop into the Best.

Ground Firebrick for Furnace Repair

BY JOSEPH HARRINGTON

RESULTS from experience with special bond made principally from old firebrick for laying up new walls and of a mortar for facing or patching. Thick joints of this bond show a saving of 35 per cent over the thin cement joint construction.

IN THE issue of *Power* of Jan. 3, 1922, the writer described the development of a special monolithic furnace lining that was being worked out by James A. Faulkner, who was then the boiler-room engineer at the Cleveland Electric Illuminating Company's Seventieth Street plant. This article treated in brief of the utilization of old firebrick bats which, being ground and mixed with a small percentage of high-temperature cement, constituted the material used in the relining of boiler furnaces. It promised not only to be a great economy, but involved several interesting phases of high-temperature work. A number of high-set Stirling boilers were relined with this material, with such excellent promise that Mr. Faulkner has since carried the work along commercially to a more extensive degree. It is the result of this later work that should interest combustion engineers generally.

The first result of using old furnace linings that had been partly destroyed was the shortage of old material, and inasmuch as the entire remaining portion of the old firebrick was used without the addition of new material, it early became evident that additional new material would have to be used. This resulted in the development of a plastic bond to be used as mortar in setting up new firebrick walls.

For many years it has been recognized as a cardinal principle in furnace work that the mortar or clay used to form the joints in the brickwork should be of the

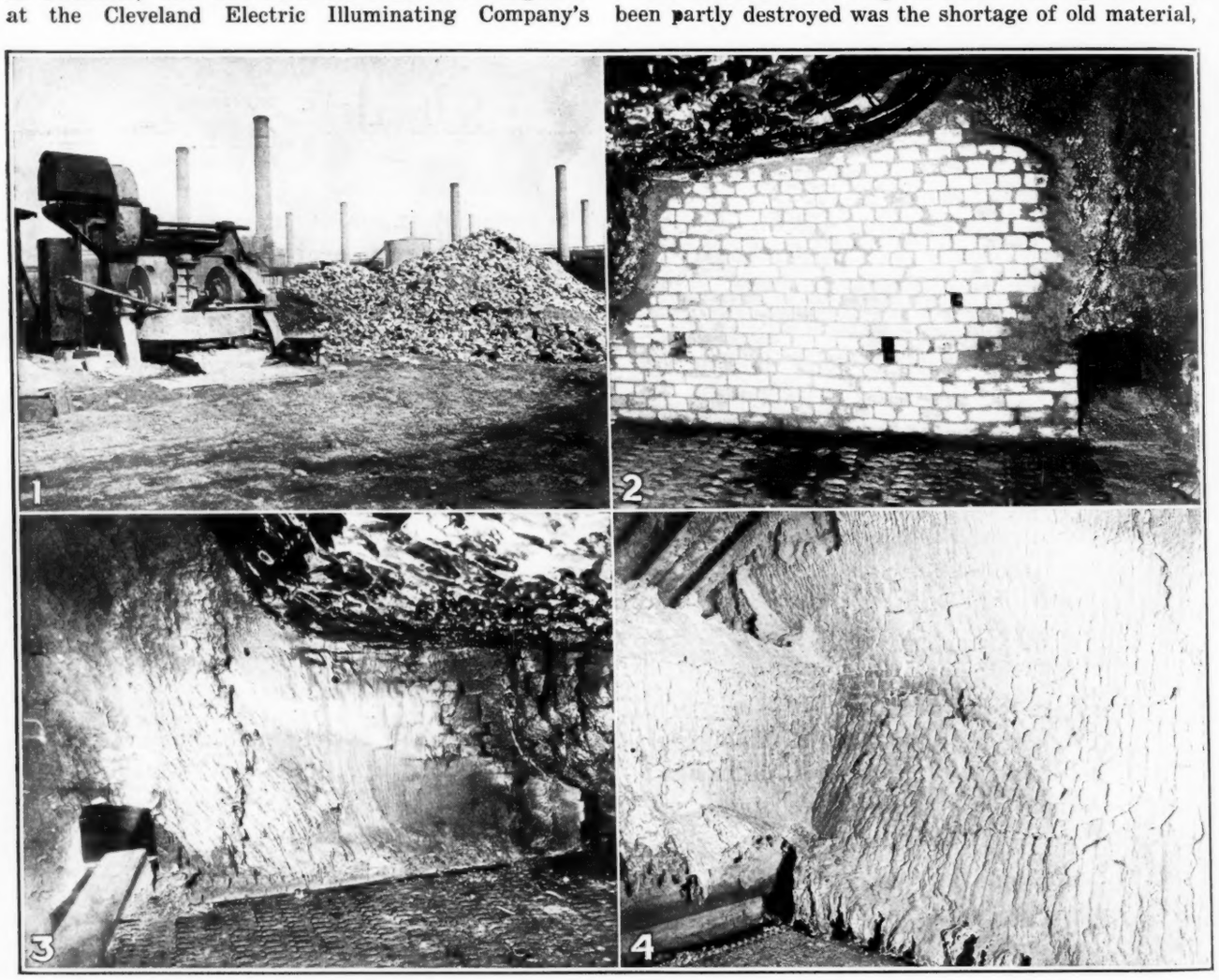


Fig. 1—Wet pan for grinding and mixing the brick bats and special bond

Fig. 2—Furnace side wall with heavy joints of special bond

Fig. 3—Same wall as in Fig. 2 after seven months' run

Fig. 4—Furnace side wall ready for repairs

same chemical characteristics as the brick itself, to avoid having the mortar act as a flux, and in order that its fusing point would be the same as that of the brick. When this basic principle was violated, it was found that the clay joint melted out at a lower temperature than the brick, leaving openings that allowed the furnace gases to attack the brick on more than one face and cause rapid deterioration. Moreover, the clay in its fluxed condition offered opportunity for mechanical attachment of particles of ash blown or lifted from the fuel bed, building up in this way on the side walls a slag deposit that frequently became destructive, the walls suffering when the slag is broken away.

It is almost an ideal situation in which the mortar is made up of the same firebrick as used in the wall itself. Under these circumstances the mechanical and the physical characteristics are identical, and it has been found that a joint so made does not fuse or flux. As a result thicker joints can be made, courses evened up and holes filled in at will without injurious effect and at a much lower expense.

To develop such a product as this, experimentation was required because it had to have a considerable degree of plasticity and at the same time had to set up strongly enough to take the weight and carry the stresses incident to furnace linings. A simple fireclay bond made up of a high-grade clay was not strong enough and had but little plasticity, so that to this base was tried the addition of portland cement, sodium silicate and other chemicals. Finally a bond that seemed to fulfill all the requirements was developed, and it is now being used with success for this purpose.

In connection with the process there developed a mechanical problem that also required attention before it was solved. Hand mixing, no matter how carefully executed, resulted in a sandy product, and when further moistened, the finer parts washed out of the mixture. To render this material permanently plastic, it was found necessary to subject it to the influence of the heavy mullers or wheels of certain familiar machinery used in the preparation of brick. The type of machine is well illustrated in Fig. 1, which also shows a pile of old brickbats removed from furnaces and ready to be ground.

An interesting phase of this work from the financial side, is indicated in the accompanying tabulation, show-

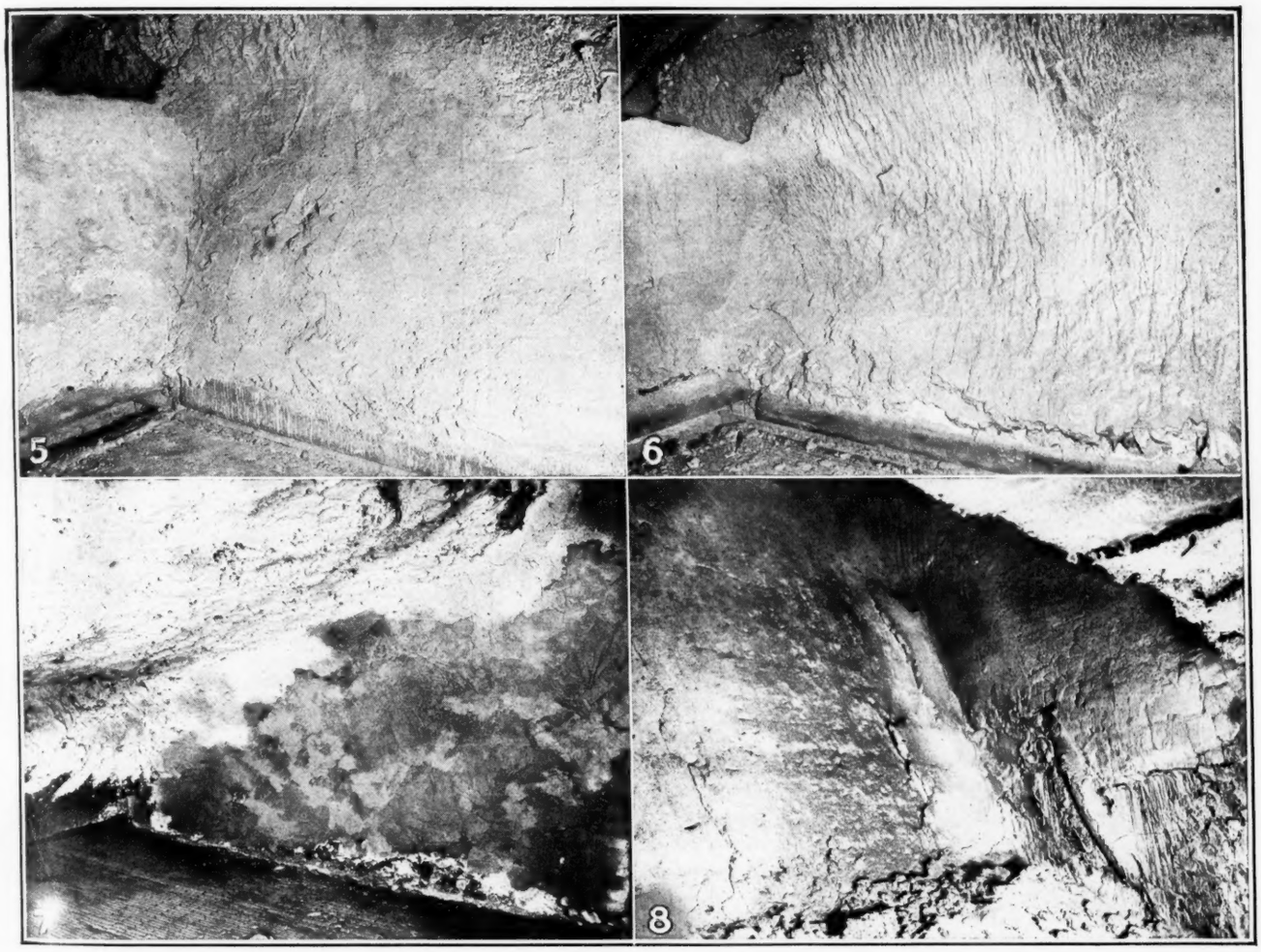


Fig. 5—Side wall of Fig. 4 plastered with refractory mortar without removing old brickwork

Fig. 6—Wall of Fig. 5 after five weeks' service. Practically unbroken surface

Fig. 7—Furnace side wall plastered with the refractory mortar

Fig. 8—High sloping bridge wall of monolithic construction after several months' service

ing the relative cost of brickwork laid up with thin and thick joints.

COMPARATIVE COSTS OF 100 CU.FT. OF BRICKWORK

Thin Joints

20 bricks per cu.ft. = 2,000 brick @ $50	$100.00
500 lb. h.t. cement per 1,000 brick = 1,000 lb. @ 4c.	40.00
	$140.00

Thick Joints

100 cu.ft. — 15 per cent requires 1,700 brick @ $50	$85.00
1,000 lb. mortar per 1,000 brick = 1,700 lb. @ $7.50 ton	6.38
	$91.38

A saving of $48.62, or nearly 35 per cent.

It will be noticed from the table that thick joints in brickwork occupy about 15 per cent of the volume, and when this is made up of a material identical with that of the bricks themselves, the product is in effect a monolithic wall, at least so far as its uniform chemical and physical characteristics are concerned.

Under the former method of relining furnaces when nearly worn out and throwing away the old material, experience shows that an actual wastage of one-third of all the firebrick was suffered. There being room for about 15 per cent of special mortar in the wall, it follows that there will accumulate considerate material unless it is used in quantities for laying up monolithic walls and for similar service, so that there still remains as an interesting phase of the problem the ability to utilize the mortar for such work. Also it can be spread over old and partly worn out furnace linings, to which it will adhere and over which it will form a protective coating that can be renewed from time to time with practically no further deterioration of the underlying brickwork. When sufficient material accumulates, the entire bridge wall or possibly an arch can be laid up with this material.

To illustrate, Fig. 2 shows the side wall of a boiler furnace laid up with new firebrick and fairly thick joints. This was a repair job, as evidenced by the appearance of the surrounding parts. After seven months of hard service with practically continuous operation in the vicinity of 250 per cent of rating, the photograph shown in Fig. 3 was taken. It actually shows the opposite side of the furnace, but the conditions were much the same, being satisfactory on either side.

Fig. 4 shows the interior of a boiler furnace laid up in the usual manner before repairs were made. This wall was about ready for complete replacement, but the special material under description was used and laid on with a trowel. It consisted of 80 per cent of old firebrick and 20 per cent of the special bond. The appearance of the wall when the work was finished is indicated in Fig. 5, and Fig. 6 shows the same wall after five weeks' service.

Another side wall that had been in service four months is shown in Fig. 7 and in Fig. 8 a high bridge wall built up as a monolithic structure and photographed after several months' service. As indicated in Fig. 9, the bridge wall was constructed by a method similar to that described in the first article in *Power*.

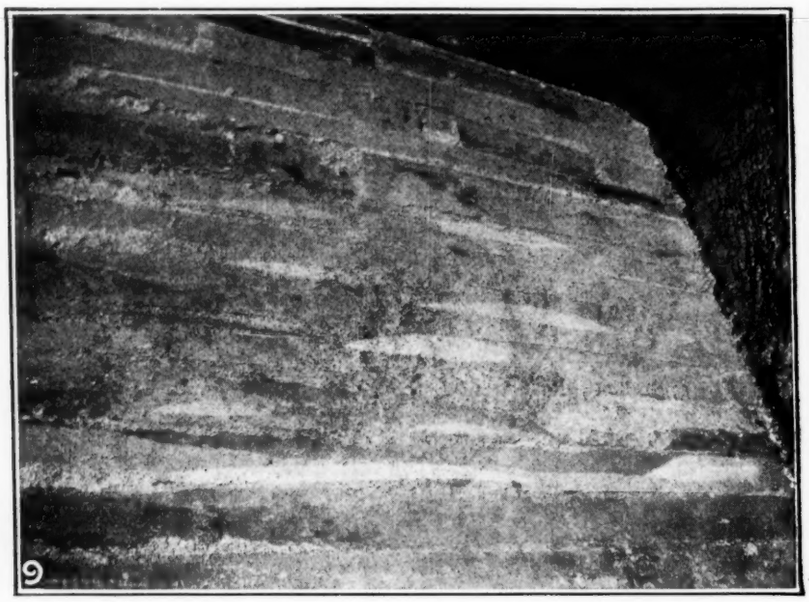


Fig. 9—Method of building bridge wall of Fig. 8 by the monolithic method

Fig. 10—Patching a side wall with refractory mortar

Wooden forms were put up foot by foot and the material pounded in place behind the forms, after which the forms were removed and the wall given a slow drying. No attempt was made to smooth up the work.

A patch in a side wall built up in this way is shown in Fig. 10. It is interesting to note that a large, irregular patch can be applied in this manner and the material pounded in place along the sides to make a joint with the brickwork. Evidently, extensive repairs can be made without any special reference to dimensions or surroundings.

The practical side of these methods lies in their economy, secured through a lower cost per cubic foot in both material and labor, the lessened loss by radiation and infiltration and the longer period between repairs. Anything that genuinely decreases furnace maintenance is worthy of careful consideration.

[This article discusses the monolithic method of furnace repair only. In a subsequent issue will appear a discussion of the application by an air gun of a hydrated mixture of ground firebrick and fireclay, based upon reports from a number of large plants.—Editor.]

Testing Steam Turbine and Barometric Condenser

By FLOYD S. YOUTSEY
Consulting Engineer, Collinsville, Ill.

IN THE June 10 issue a mixed-pressure steam turbo-generator installation at the mining property of the St. Louis Smelting & Refining Works of the National Lead Company at St. Francois, Mo., was described. It will be recalled that this unit, a 1,562-kva. machine, was served by a barometric condenser. When this unit was to be tested at the plant, it was found necessary to improvise a method, which may be of general interest.

To test a barometric or jet condenser, apparently the only way of determining the amount of steam used is either by a steam-flow meter or by some method of measuring the heat in the steam. It is usually considered that the steam-flow meter gives approximate values not sufficiently accurate to satisfy test conditions. If the quality and temperature of steam entering the condenser could be determined, it would be possible to compute the amount of steam used by measuring the injection water. The writer knows of no method whereby a sample of steam can be withdrawn at 28-in. vacuum and the quality determined, so that the following plan was devised.

Determining the quality of the steam at the turbine throttle, gives the data for obtaining the heat per pound of entering steam. Assume that this heat is divided into three parts. The major portion, designated as *A*, is absorbed in the injection water and raises its temperature while passing through the condenser. The second portion *B* is the amount of heat converted into electrical energy and is measured by a watt-hour meter on the switchboard, while the third portion *C* is dissipated into various channels, among these being the heat in the air leaving the generator which is picked up in cooling the coils. Another portion is the heat produced by the friction of the journals, which usually leaves the machine in the circulating oil, and the heat carried away by radiation and convection from the surface of the unit. In this final or *C* group it will be seen later that the major portion of the losses can be estimated without materially affecting the final results. In the computation of the test shown herewith, the losses in group *C* were taken arbitrarily as 10 per cent of the gross output of the turbine blades, or one-ninth of the net output of the generator.

The set-up of the apparatus and instruments for the test is shown in Fig. 1. It is important that the weir

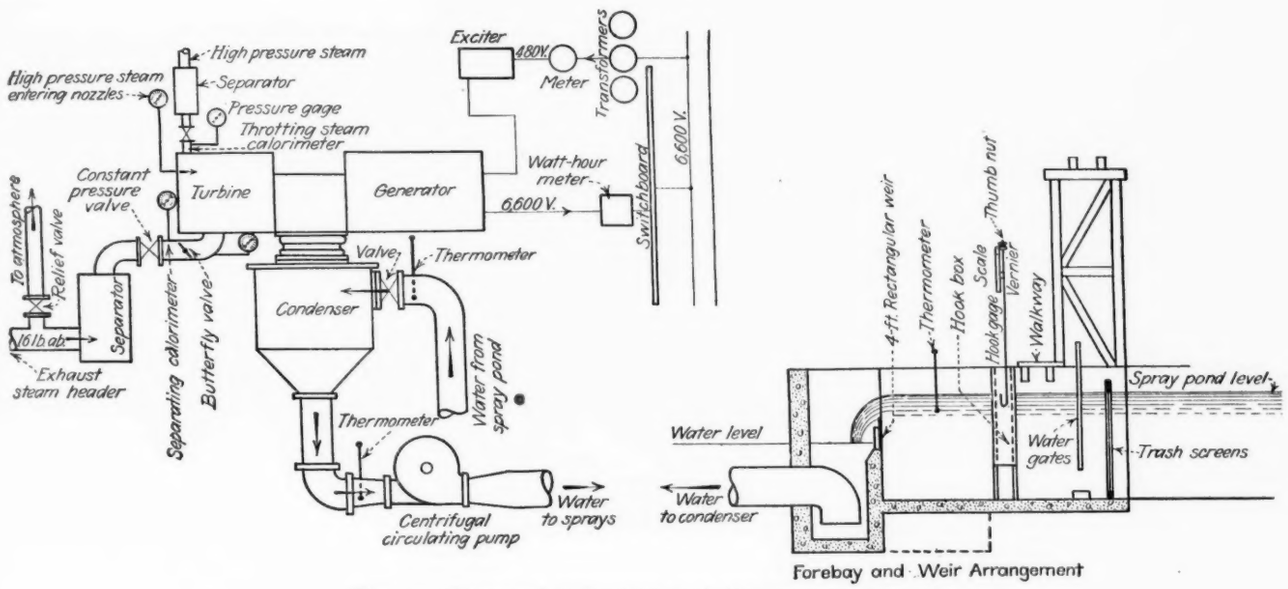


Fig. 1—Set-up of apparatus and instruments for test

readings and the temperatures of the injection water to and from the condenser be taken with the utmost accuracy. In this instance the weir was read by means of a vernier and hook gage of the usual pattern. Computations were made in accordance with the United States Water Supply and Irrigation Paper, page 200, and corrections were made for water temperatures. Centigrade thermometers were used on the injection water, graduated into 100 divisions per degree that could be read easily with the naked eye and were accurate to less than 0.01 degree.

The quality of steam entering the turbine was determined by the throttling calorimeter, and a separating calorimeter was used for the low-pressure steam. The wattmeter was checked and found to be within 0.3 of 1 per cent of the test instrument. In running tests an effort was made to regulate the amount of injection water so that the temperature rise should be 10 deg. or more to reduce the possible error in thermometer reading over a shorter range.

Following the steam through on the heat entropy diagram, Fig. 2, the starting point is at 154 lb. abs. and entropy 1.56. The steam is wiredrawn to 114 lb., entropy 1.59, and then following an unknown path, is expanded and wiredrawn to 0.79 lb. to a point opposite 964.6 total B.t.u., which gives a quality of 0.87 and an entropy of 1.75.

It may seem inconsistent to use such precision in determining the weight and the temperature rise of

TEST DATA WITH TURBINE USING HIGH-PRESSURE STEAM

Duration, minutes	60
Kilowatt-hours delivered on switchboard	1,391
Steam pressure, lb. abs.	154
Quality of steam	0.993
Steam entering turbine nozzle wire drawn to, lb. abs.	114
Temperature cooling water entering condenser, deg. F.	73.88
Temperature cooling water entering condenser, deg. F.	85.77
Temperature rise, deg. F.	11.89
Water passing weir, lb.	1,807,600
Vacuum in condenser, ref. 30 in. bar., in.	28.38
Vacuum in condenser, lb. abs.	0.79
Heat in 1 lb. steam as admitted to turbine, B.t.u.	1,188
Heat in liquid from 1 lb. of steam leaving condenser, B.t.u.	53.77
Heat, absorbed by *A*, *B* and *C* per lb. of steam, B.t.u.	1,188–53.77=1,134.23
B.t.u. absorbed by *A*	1,807,600 x 11.89=21,492,364
B.t.u. absorbed by *B*	1,391×3,411=4,744,701
B.t.u. absorbed by *C*	½×4,744,701=527,189
Total B.t.u.	*A*+*B*+*C* = 26,764,254
Steam used in test, lb.	26,764,254 ÷ 1,134.23 = 23,597
Steam per kw-hr. del. to switchboard, lb.	23,597 ÷ 1,391 = 16.96
Heat absorbed by *B* and *C*, B.t.u.	5,271,890
Heat to *B* and *C* per lb. of steam, B.t.u.	5,271,890 ÷ 23,602 = 223.4
Heat in steam entering condenser, B.t.u. per lb.	1,188 — 223.4 = 964.6

the injection water, but items *A* and *B* contain about 98 per cent of the heat, and if these values are determined accurately, an error in *C* becomes insignificant. Suppose that item *C* be increased by 50 per cent, the resulting unit steam consumption would then amount

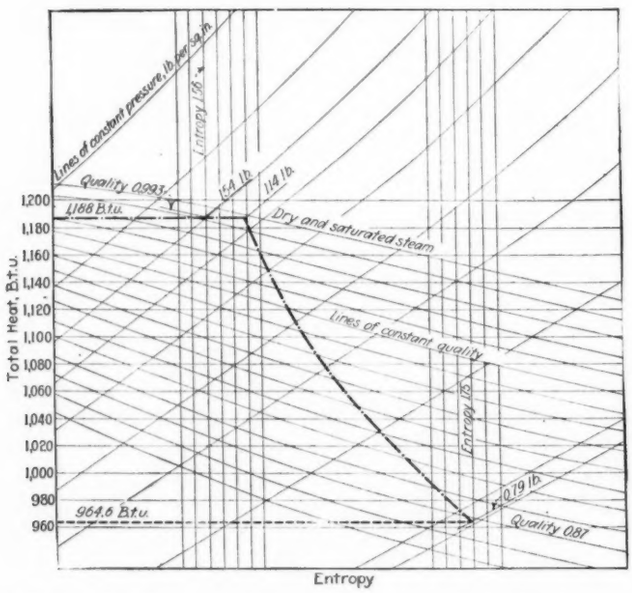


Fig. 2—Following path of steam on entropy diagram

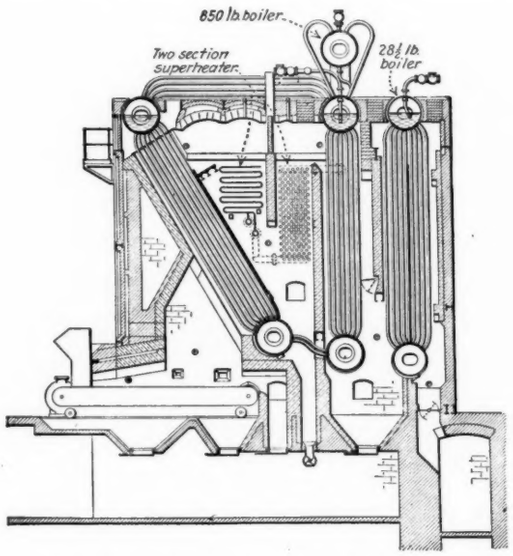
to 17.13. If item *C* be taken at one-half the amount given in the test, the steam rate becomes 16.8. Notice that the variation over these wide assumptions is less than 1 per cent from the test figures.

The primary cause of pitting in turbine runners is high draft head resulting in nearly complete vacuums on surfaces of the runners. Pitting occurs where the main stream of water pulls away from the surface and where the vacuum draws from the passing stream a spray of water and oxygen released by the draft head. The oxygen becomes highly concentrated because of the violent eddies set up.

High- and Low-Pressure Boilers in Same Setting

By Bruno Shapiro

On the European Continent boilers with considerably inclined tubes are preferred. The boiler may be seen in the figure for 850 lb. with a heating surface of 3,240 sq.ft. and a superheater as well as a low-pressure boiler



Steep tubes characterize foreign high-pressure boiler

for 28½ lb. The boiler was constructed by Schmidt Heissdampf Company in Cassel (Germany) together with the firm of A. Borsig in Berlin.

This design differs slightly from the one shown in *Power*, 1923, vol. 58, p. 164. The diameter of all five of the forged-steel drums is 35.43 in., and their walls are 1.89 in. thick. The two front steel drums are connected by 148 water tubes and 28 downcome tubes, the two back steel drums by 130 water tubes and 22 downcome tubes; the outer diameter of these water tubes and downcome tubes is 2.362 in. and their walls are 0.157 in. thick. The superheater consists of two sections, having 24 and 26 coils, the outer diameters of which are 1.378 in. and their walls 0.197 in. thick. The seamless drawn tubes are made like the steel drums of a kind of steel showing an increment of its mechanical strength at a certain range of temperature.

The usual practice with large horizontal-shaft steam turbines is to allow a total clearance of about 1½ thousandths for each inch of shaft diameter. On this basis if the shaft is concentric with the bearing, a 10-in. shaft will have a radial clearance of 7½ thousandths. This clearance is necessary to admit a sufficient volume of oil under pressure to support and flush the shaft. If this clearance is increased to the point where gyration of the shaft is produced, there are two vibrations set up, one due to the lack of perfect mechanical balance and the other to the gyration. These vibrations tend to oppose each other until a speed is reached when they are in synchronism. This speed is known as the critical speed of the machine. It usually occurs about 25 per cent below the operating speed. It is obvious that in bringing machines to speed, this point should be passed as quickly as possible.

Ice Plant Installs Unaflow. Engines

Ice plant at Memphis, Tenn., economizes by purchasing governmental excess machinery; increases plant more than one hundred per cent, but adheres to distilled water system.

THE prevalence of the raw-water ice plant is such that usually the question put to the engineer by the visitor after introductions have passed, is, "What do you have, the low- or the high-pressure air agitating system?" That the distilled-water ice system is not a back number is attested by the large number of plants having their own power that still use this system. It is conceded that the raw-water system is economical where electric power is available at low rates, but many, including the Broadway Coal & Ice Co., of Memphis, have found that the superior marketing value of distilled-water ice when manufactured in a plant having efficient prime movers makes this system the most economical in the long run.

For many years this plant depended upon a 50-ton vertical two-cylinder single-acting compressor direct connected to a horizontal simple Corliss engine. Steam was furnished by a 3,000-sq.ft. water-tube boiler located in the boiler room adjacent to the engine room.

Increased demand for ice necessitated the enlargement of the compressor capacity as well as that of the can-ice tank. The government was disposing of the equipment at the Old Hickory Powder Mill which included a number of high-speed compressors direct connected to unaflow engines. Advantage was taken of this opportunity, and an 18x24-in. horizontal double-acting compressor direct connected to a 23x24-in. unaflow engine was purchased. This unit is rated at 175 tons refrigerating capacity when turning at 175 r.p.m. To permit the compressor to have a variable capacity to meet the fluctuations in the load demand, after the unit was installed in the ice plant the engine builders replaced the standard governing mechanism by a variable-speed control. This consists of a fixed eccentric, the rod of which is connected to the valve rocker arm; the other end of this rocker is attached to the rod of the movable governor eccentric. The valve rod carries a block capable of being shifted along the rocker arm by means of a hand-operated rack and pinion and so obtaining any desired speed. This permits a variable compressor speed and capacity ranging from 25 per cent to full load, making the unit economical for all-year service.

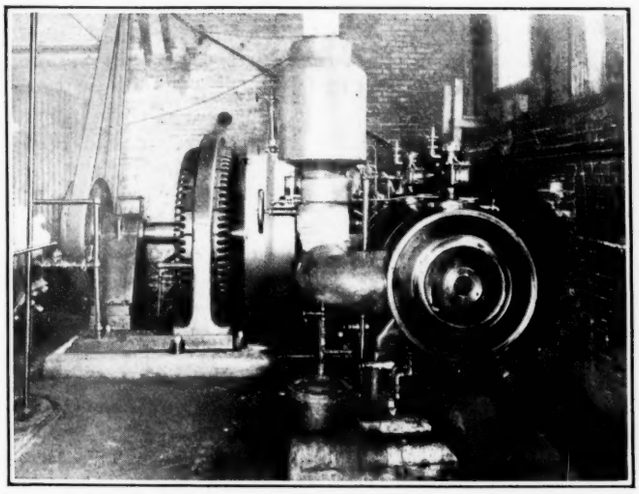


Fig. 2—Unaflow engine set supplies current for auxiliaries

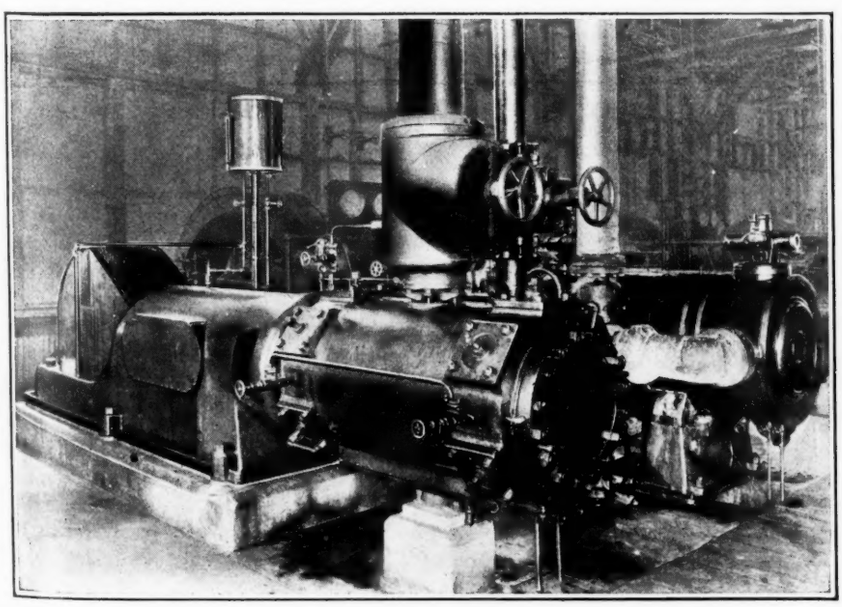


Fig. 1—De La Vergne High-speed compressor direct connected to Ames unaflow engine

Electric power is supplied to the several motor-driven auxiliaries by a 125-kw. 220-volt three-phase 60-cycle generator direct connected to an 18x24-in. 225 r.p.m. unaflow purchased at the same time as the compressor unit.

The existing boiler-room equipment was, of course, entirely inadequate to meet the increased load demands. Consequently, a 5,000-sq.ft., 150-lb. pressure, horizontal water-tube boiler was installed alongside the older unit. Vertical baffling was used, consisting of five inches of high-temperature cement.

In view of the fact that West Kentucky bituminous coal of pea and slack grades was to be used, inclined mechanical stokers of the shaker-grate type were installed under both boilers. The stoker drive is through a shaft along the front of the boilers, power being furnished by a 5-hp. squirrel-cage motor with a speed-reduction worm gear. Natural draft is supplied by a 5 ft. self-supporting steel stack 125 ft. high and made of 8-gage steel.

The ashes are removed from the boiler room by means of a trench under the dump grates through which flows

the waste water discharged from the surface condensers.

Water is obtained from an 8-in. well, the temperature averaging 62 deg. F., and since the water contains no scale-producing minerals a treating plant is not needed. The air-lift system used in lifting the water from the well receives its air supply from a flywheel-type steam-driven 10x12-in. 80-lb. compressor. This machine is acting as a stand-by, a 10x12-in., 100-lb. pressure high-speed compressor, belt driven by a 60-hp. 1,154 r.p.m. squirrel-cage motor now supplying the air.

A 12x18x12x12-in. compound duplex pump delivers the water to 22 stands of double-pipe ammonia condensers placed on the tank roof 60 ft. above ground and some 25 ft. from the main building. The water then flows by gravity over six 20-ton copper surface steam condensers which furnish the distilled water. To eliminate all oil from the exhaust steam coming from the engines, a 12-in. separator was placed in the exhaust line.

How the Water Is Treated

The distilled water leaving the condensers flows by gravity to a skimming tank, where any oil or like contamination is removed. From the skimmer two 4½x3¾x 3-in. duplex pumps lift the water to the reboilers set on the building roof. These reboilers of 140 tons total capacity are connected in series both as to the water and the steam. This series method of operation gives a complete expulsion of four gases from the water with a very low consumption of steam and, in addition, delivers the water to the flat coolers at a lower temperature than is possible with parallel connections.

After reboiling, the water flows through stands of flat coolers, each six pipes high, into a coke filter, this filter being connected by an equalizer with six 20-ton charcoal filters. After this treatment the water passes into two storage tanks; one, of 7,000 gal. capacity, is cooled by

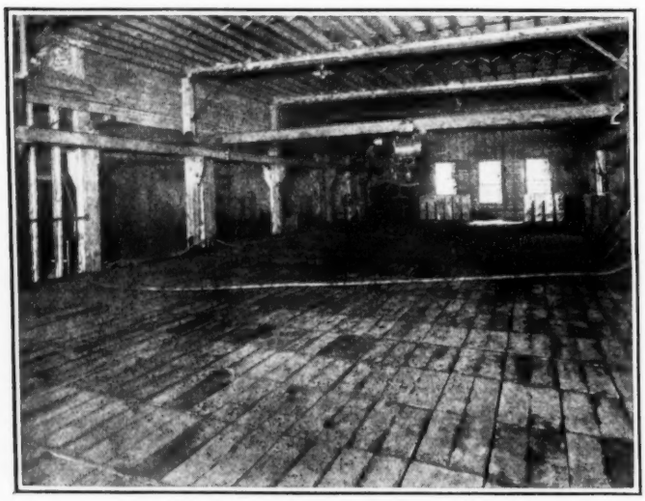


Fig. 3—View of new can tank

the ammonia suction line from two of the brine tanks, and the second, of 5,000 gal., by direct expansion.

To store the liquid ammonia after it leaves the condenser, there are two 30-in. by 18-ft. vertical receivers. These are equipped with safety valves set to blow at 240 lb. gage at the tops, where are also located the purge connections. Both discharge and suction lines are provided with separators and traps for the elimination of all oil carried over from the compressor.

Each of the two original freezing tanks contains 420 300-lb. cans and is set on a brick and wood superstructure and insulated with six inches of cork board on the bottoms and twelve inches of granulated cork on the sides and ends. A brine temperature of 12 deg. F. is maintained by direct expansion. Two 12-in. horizontal brine agitators, belt driven by a steam engine, are placed in each tank. The new tank contains 726

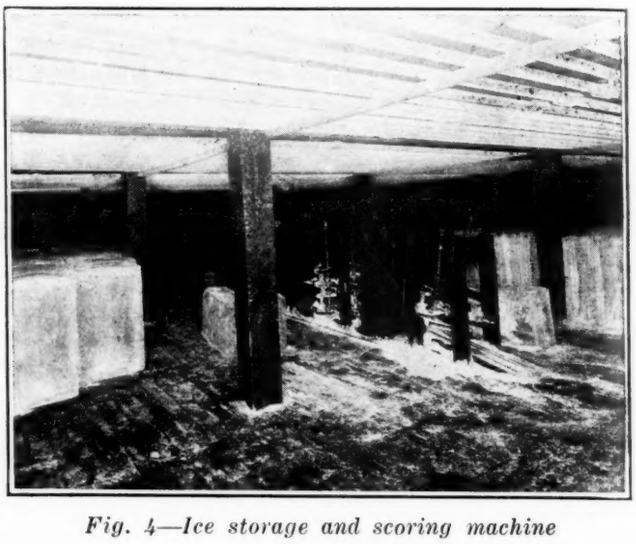


Fig. 4—Ice storage and scoring machine

cans and is set on reinforced-concrete foundations and insulated on the bottom with six inches of granulated cork. A brine temperature of 12 deg. F. is maintained by the flooded system, with a 75-ton vertical accumulator half submerged and both suction and discharge headers submerged. A 15-inch vertical high-speed motor-driven agitator is placed in each end of the tank.

Ice is pulled from all three tanks by two block lift hoists and thawed by submersion in a dip tank. Space below the new tank is used for a workshop.

Ice-Storage Facilities

At present there is a daily storage of only 150 tons, with provisions made to enlarge to 500 tons. The building is of brick construction, with reinforced-concrete floors, leaving space for increased storage below. Four inches of corkboard, mastic finish, is used for insulation. A temperature of 29 deg. F. is maintained by direct expansion through overhead coils. All entrances are closed by special doors and chutes. Retail ice is sawed by a scoring machine, eliminating the use of a handsaw. The scoring machine has reduced wastage 50 per cent, and 20 per cent in time is saved in handling the retail trade, both on the platform and wagon delivery.

During the summer season the plant is run day and night on two shifts, with a crew consisting of two engineers, two firemen, two oilers, four tankmen and three vault men.

The general arrangement of boilers for 350 lb. has proved well suited for 600 lb. operation in several German plants, according to information recently received. Ten plants are reported as thus equipped, using Bruenner boilers, similar in construction to B. & W. boilers of 350 lb. in this country. It is said that the general operation is somewhat better at the higher pressures than at the lower.

Reconnecting Direct-Current Armature —Fractional-Pitch Windings

Explains Effects of Reducing Pitch of Armature Coils and How Chording Coils May Make It Possible to Use Coils That Have Been Made Too Short for Full Pitch

BY A. C. ROE
Repair Superintendent, Detroit Service Department, Westinghouse Electric & Manufacturing Company

IN MANY cases when an armature is being rewound, the coils are made up and when they are being put into the slots it is discovered that in some manner they have been made shorter than those in the old winding and that when part of the coils are in place they start to bind. At this stage it is well to know when and how to determine what effect on the operation of the machine will result if the pitch of the coil is shortened one slot, which in nine cases out of ten will enable the short coils to be used. Dropping the coils back one slot will have the effect of lengthening the coil ends and ease them from crowding.

The full pitch of any direct-current two-layer armature winding is equal to one and the number of slots divided by the number of poles plus one. For an armature having 40 slots wound for 4 poles, full coil pitch equals 1 and (40 ÷ 4) + 1, or 1 and 11. This means that if the top half of the coil is in slot No. 1 the other side is in slot No. 11. With the coils spread full pitch, when one side of a coil is under the center of a north pole, the other side is under the center of the adjacent south pole to the right or left according to how the armature is wound. In some cases full pitch cannot be physically obtained; that is, with 49 slots and 4 poles, full pitch equals 49 ÷ 4 = 12¼ slots. The nearest to full pitch is 1 and 13, which is ¼ of a slot under pitch. With 51 slots and 4 poles, full pitch equals 51 ÷ 4 = 12¾ slots; then a coil pitch of 1 and 13 would be ¾ of a slot under pitch, or the coils are chorded ¾ of a slot.

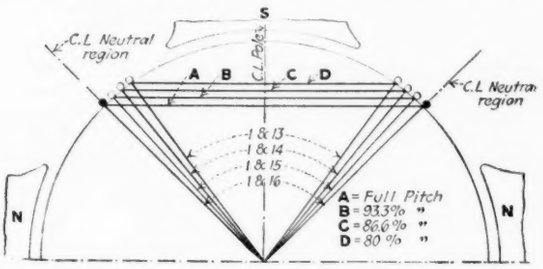


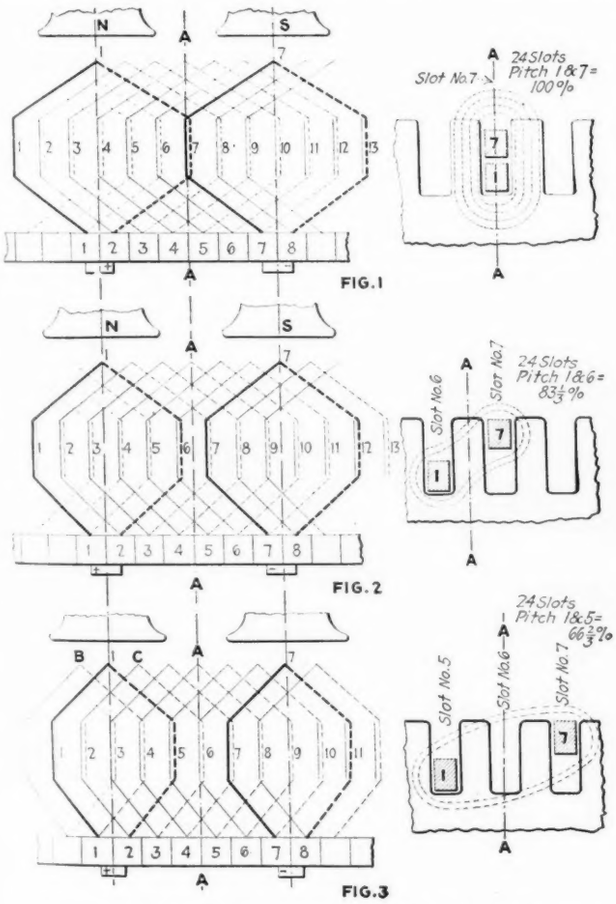
Fig. 4—Correct position of coils under commutation

In direct-current machines the coil pitch is expressed as a percentage of full pitch, that is, 100 per cent pitch, 90 per cent, 80 per cent, etc.; 80 per cent being about the lowest chording and 95 to 85 per cent in average values. Where the coils have less than full pitch, the winding is sometimes referred to as a fraction-pitch winding, or the coils are said to be chorded.

CHORDING COILS DECREASES SELF INDUCTANCE

Chording the coils in an armature one or two slots will decrease the self inductance of the coil under commutation. In Fig. 1 is shown a developed view of a section of an armature winding having 24 slots and 4 poles. With full pitch the sides of the coils under commutation will be in the same slots. In the figure coils 1 and 7 are in contact with a brush or short-circuited and the bottom half of coil 1 is in the slot 7 with the top side of coil 7. The path for the magnetic field around the coils in slot 7 is through two teeth and one slot opening, as indicated to the right in Fig. 1.

By chording the coils one slot, the reluctance of the induced flux path is increased; this is indicated in Fig. 2. Here the coil pitch is 1 and 6, and instead of one side of coils 1 and 7 falling in slot 7, the bottom side of coil 1 is in slot 6. Then with the coils under commutation in the same relative position to the neutral center line *AA*, they are separated by one tooth. This decreases the self inductance of the coils and



Figs. 1 to 3—Show effects of chording coils on a direct-current armature

assists commutation. The path that the magnetic lines about the two coils have to take is indicated to the right in Fig. 2. In this case the path is through three teeth and two slots, which results in a flux density below that in Fig. 1, consequently the self inductance in the coils is less.

Fig. 3 shows the coil pitch reduced to 1 and 5 or 66⅔ pitch. This pitch brings both sides of the coils under commutation under the tips of the same pole, which would probably cause sparking regardless of the brush shift.

Fig. 4 indicates the relative positions the coil's sides should take in reference to the center line of a main pole for different pitches. With any of the four pitches each half of the coil is equidistant from the center line of the pole, which is the position it should have when short-circuited by a brush.

How Reducing Coil Pitch Affects Voltage

The effect of a chorded pitch on the generation of voltage is shown in Fig. 5. One side of the coil is assumed to remain fixed on the center line of one pole, as indicated by the large black dot. Then, with full pitch *A*, both halves of the coil are in a maximum field, hence will generate a maximum voltage. When the coil pitch is reduced, one side is in a maximum field while the other side is in a somewhat weaker field depending upon the extent that the coil is chorded. With the pitch *B* the voltage of the coil will be less than for full pitch *A* and with pitch *D* the voltage will be still further reduced. Therefore, chording the pitch of a coil tends to decrease the terminal voltage of a generator and increase the speed of a motor. In this connection it might be well to note that the percentage change in voltage or speed is not in the same proportion as the percentage change in pitch. In fact the change in speed or voltage that can be obtained is approximately three per cent, unless the chording is carried to extremes.

Fig. 6 shows the lead throw for a lap-wound armature with full and chorded pitch, with the brushes on the center line of the neutral region *NP*. With full pitch the lead from *A* connects straight out, but with a chorded pitch the coil should have the position *BD*, which brings each side of the coil equidistant from the

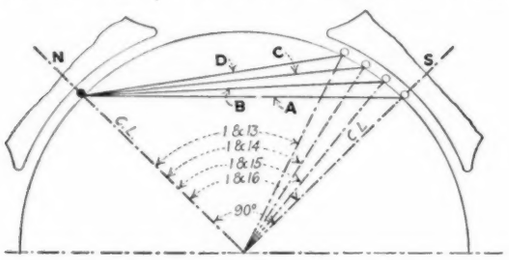


Fig. 5—Shows effect of reducing coil pitch on voltage

pole tips. Then, with the brush in the same position as for the full-pitch coil the leads must be given a throw as shown. If the lead from *B* were connected straight out, the coil under commutation would assume a position *AC*, which with fixed brushes would cause sparking at the brushes and heating of the armature. The position of the brush would have to be shifted in a clockwise direction to correct the wrong lead throw.

One case in mind is where a ¾-hp. motor had the armature rewound. There were 18 slots in the armature and the coil pitch was 1 and 9, hand wound. The winder put the connecting data down as straight out, pitch 1 and 9, but did not make a sketch showing the lead throw. When the armature was finished and the motor assembled and put on test, it ran, but sparked at the brushes, had a jerky motion and ran so hot that it began to smoke in five minutes. The brushes in this machine had a fixed position. The armature was removed and tested for short-circuits, but showed clear.

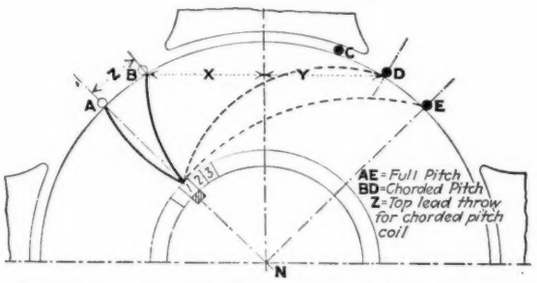


Fig. 6—Shows how changing coil pitch makes necessary a change in coil-lead throw or in brush position

Putting the armature back in the frame and turning until a marked coil was correctly spaced on either side of a pole center, the front bracket was put on and the lead traced to the commutator and found to be two bars away from the brush. The end bell was shifted to correct the brush position, and clamped in place. When the motor was started again, it ran without sparking and heating which proved the trouble to be wrong lead throw. After the armature was properly connected, it gave no further trouble.

On a non-interpole machine the armature coils can be chorded to 80 per cent of full pitch in some cases without ill effect. When a change is made in the coil pitch, the lead throw must be changed so that the coil assumes its proper position while under commutation or the brushes must be shifted.

When changing the coil pitch on interpole machines, note the number of slots under each interpole and don't chord the coils if this will cause the coil sides to come too close to the interpole tips or out from under the pole completely. The greater the number of slots the less effect chording one slot will have.

The National Safety Council, in a recent publication, sets forth nine beneficial effects of proper painting as an aid to interior illumination. These are: Reduction of accidents; greater accuracy in workmanship; decreased spoilage of product; increased production for the same labor cost; less eye strain; better working conditions; less labor turnover; better order, cleanliness and neatness in the plant; easier supervision of the men. Proper painting increases illumination, aids in light diffusion and eliminates glare. "The amount of light reflected by a given paint depends, of course, upon its color," says Walter Sturrock, of the General Electric Co. "White paint shows the highest reflection factor; that is, it reflects the greatest percentage of light striking it. A pure white surface will reflect light of all colors at equal efficiency. On the other hand, a paint having some color in it, such as blue, for example, will be an efficient reflector of blue light, but will absorb practically all red rays of light striking it. For light from Mazda lamps, a yellow paint has a higher reflection value than some of the other paints."

Pulverized-Fuel Systems—III*

Systems Used for Conveying Coal in Pulverized Form—Their Construction and Operation

By A. L. COLE†

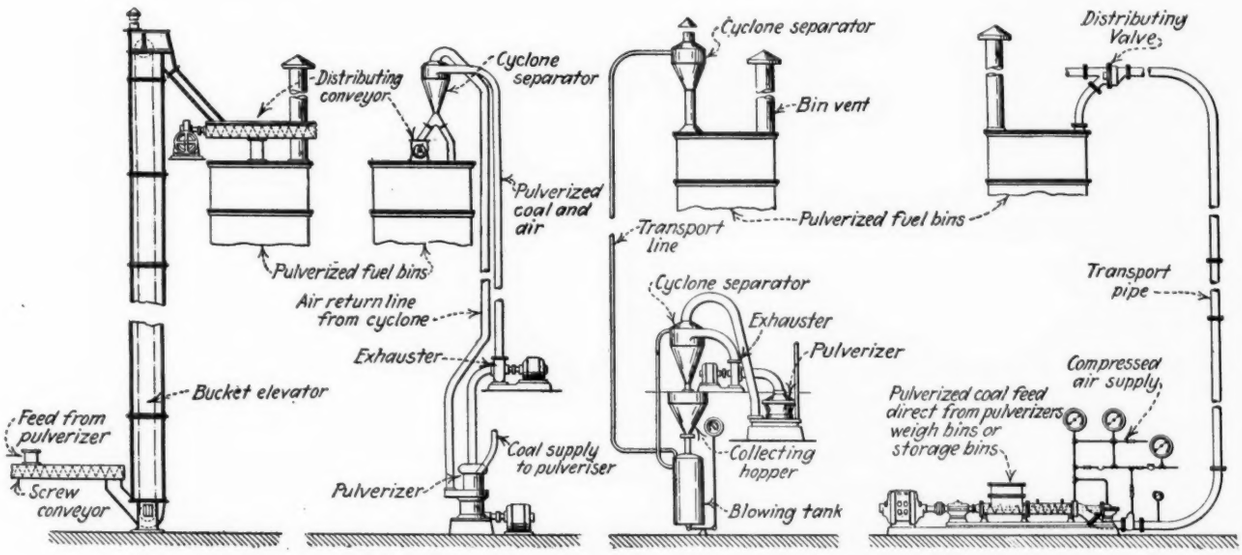
ONE of the advantages of pulverized coal is the ease with which it may be conveyed from point to point such as between the pulverizer and the storage bins or furnace. The conveying systems in general use may be divided into two classes, direct and indirect; the former includes the unit system of firing, in which the coal is discharged directly from the pulverizer to the furnace, and also the circulating systems used in connection with metallurgical furnaces, while in the indirect system the coal is conveyed from the pulverizer to a storage bin and fired by means of separately driven feeders and primary air fans. In the indirect system four distinct methods are employed: (1) Combination of screw conveyors and bucket elevators; (2) exhausters—coal conveyed in suspension in a current of air; (3) air transport—coal discharged from weigh tank under air pressure; (4) aërated flow from a high speed worm. These systems are illustrated diagrammatically in Figs. 1, 2, 3 and 4.

The oldest system of conveying the coal from the pulverizer or weigh bins to the storage bins near the furnace consists of the screw conveyor for moving the coal horizontally and bucket elevators for raising it vertically. The bucket elevator has been replaced to a large extent by the systems shown in Figs. 2, 3 and 4, but the screw conveyor is still largely used for distributing the coal to the storage bin, particularly where the system shown in Fig. 2 is employed. Several of the recent large installations in central stations have employed this method of distributing the coal as it is discharged from the cyclone collector above the fuel bins. The field of this conveyor is limited, however, it being generally used where large amounts of fuel have to be conveyed over a relatively short distance.

Probably the most common system in use where the coal is conveyed a comparatively short distance is that shown in Fig. 2, in which the coal is delivered directly from the pulverizer to the fuel bin by the exhauster. The latter may be directly above the mill or in a separate room considerable distance above, as best suits installation requirements. This is, undoubtedly, the simplest method of handling the fuel. It has the disadvantage, however, that considerable piping, usually of galvanized iron and of fairly large diameter, is required, since in addition to the discharge pipe from the exhauster, a return air pipe is necessary from the cyclone to the pulverizer, and where a number of mills are installed a screw conveyor or some other means must be employed to distribute the coal between the bins in order to provide flexibility in the operation of the equipment.

The system illustrated in Fig. 3 was first put into commercial use about 1914 and has been employed quite extensively for distributing the pulverized coal from the preparation plant directly to the bins at the various furnaces.

The system involves the use of one or more blowing tanks and a compressed-air supply. The pulverized coal is fed to the tank by gravity from an overhead bin or collecting hopper through a gate and airtight inlet valve. The blowing tank is usually supported on a

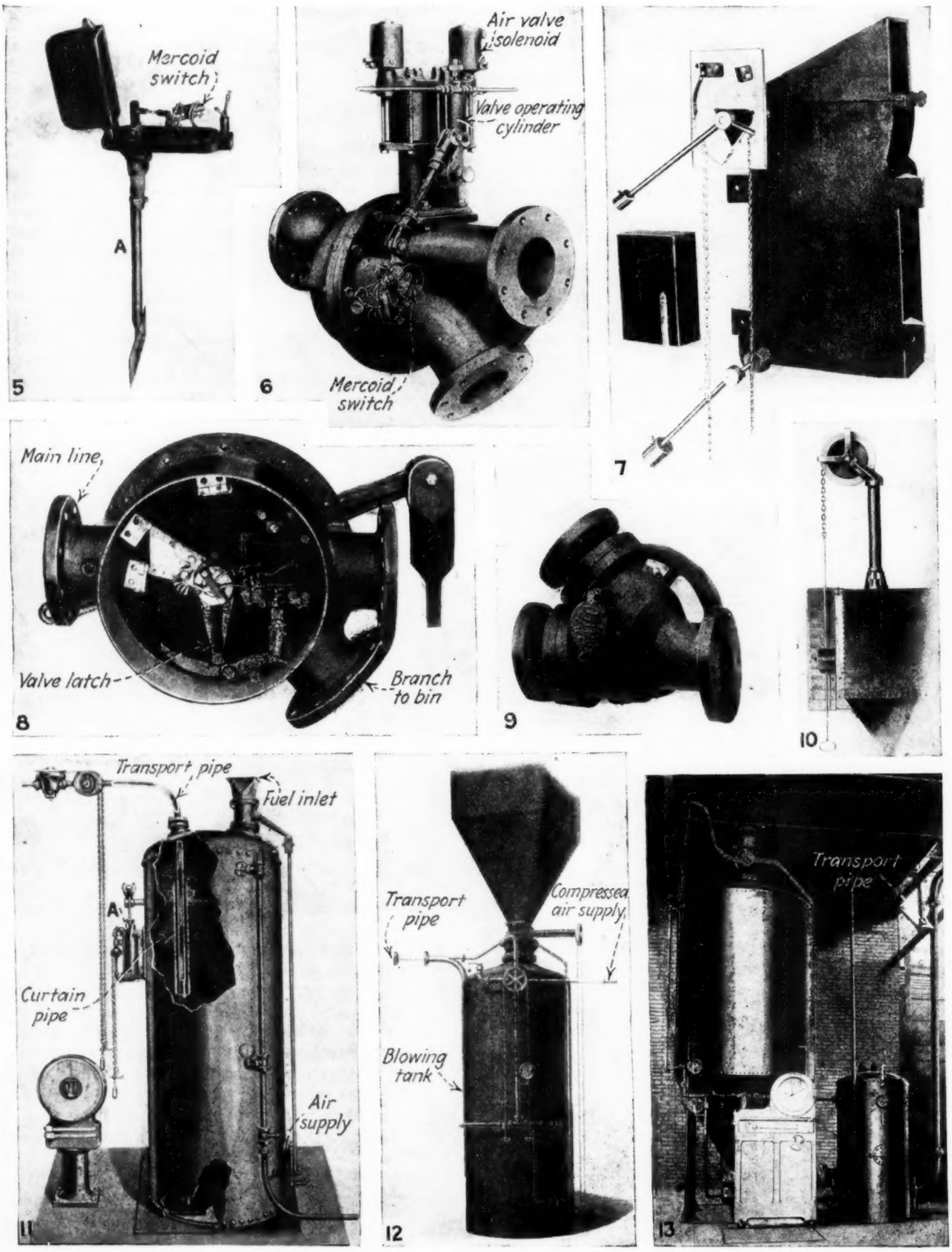


Figs. 1 to 4—Diagrammatic layout of pulverized fuel conveying systems now in general use

Fig. 1—Combination screw conveyor and bucket elevator. Fig. 2—Coal conveyed in a current of air. Fig. 3—Arrangement of compressed air transport system. Fig. 4—Combination worm pump and compressed air conveying system.

*This is the third article of the series; the others appeared in the issues of June 3 and 10. A fourth will appear next week.

†Assistant editor of *Power*.



Figs. 5 to 13—Views of bin indicators, switching valves and transport tanks

Figs. 5 and 6—Bin level indicator and electro-pneumatic distributing valve of the Fuller-Kinyon conveying system. Figs. 7 and 8—Grindle bin-level indicators and electrically operated distributing valve. Fig. 9—Raymond hand-operated switching valve. Fig. 10—Tester gage for determining amount of fuel in bin. Fig. 11—Principal features of the blowing tank Fuller-Quigley air transport system. Fig. 12—Raymond blowing tank used with the compressed air transport system. Fig. 13—Grindle pneumatic conveyor feeding unit.

scale of the beam or dial type and attached to the hopper by a flexible connection, thus providing a means of recording the amount of coal supplied to each storage bin.

Referring to Fig. 11, the transport pipe through which the coal leaves the tank enters at the top and extends to within a few inches of the bottom of the tank. A curtain pipe of slightly larger diameter is

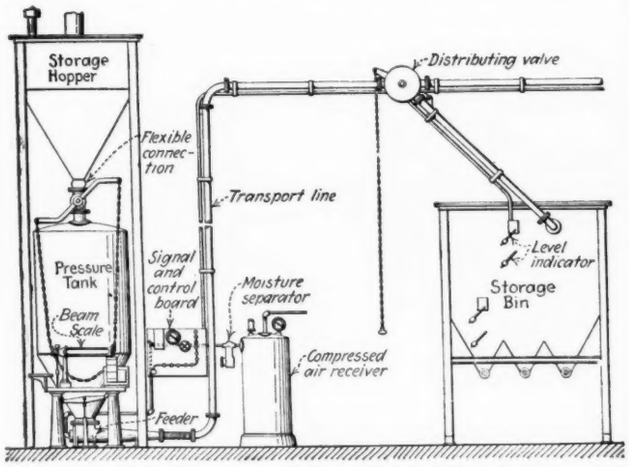


Fig. 14—Diagram of a complete grindle conveying system

placed around the transport pipe and is raised or lowered by means of the pneumatic cylinder *A* on the side of the tank. The lowering of the curtain pipe cuts off the supply of fuel to the transport line. In operating this system, compressed air at around 50 lb. pressure is admitted to the top of the tank and when the desired pressure is reached the curtain pipe is raised, the shut-off valve is opened and the coal starts to flow through the transport line. The air mixes with the coal only to a limited extent, and it is claimed that the amount used is less than one per cent of that necessary to form a combustible mixture.

For distributing the coal from the main transport pipe to the several bins, a switching valve of the hand or electrically operated type is employed; at the discharge end the pipe is led to a cyclone collector, where the air used to propel the fuel through the pipe is separated from the coal and escapes through a vent, the coal falling by gravity to the storage bin.

The blowing tank shown in Fig. 12 operates on much the same principle, except that a pressure from 60 to 80 lb. is maintained in the tank and a jet of air at a lower pressure, ranging from 10 to 30 lb., is injected into the transport pipe to assist in forcing the coal through the line.

The conveying systems shown in Fig. 13 differ from those illustrated in Figs. 11 and 12 in that, instead of the air being admitted directly to the top of the weighing tank, it is admitted through an automatic pressure-control valve to a special feeder below the tank. The feeder is essentially a cylindrical casting tapered down at the discharge end to standard pipe dimensions and containing a series of air jets which aërate the coal and force it through the pipe line to the storage bins. A large air receiver and a moisture separator form an essential part of the air system; a secondary separator is incorporated in the feeder to insure only dry air coming into contact with the coal. At each bin a switching valve shown in detail in Fig. 8 is placed in the main transport line, each valve being arranged for operating by hand or electrically as desired. The coal-level indicator shown in Fig. 7 is part of the automatic control used with this system. The box part of the indicator is placed on the inside of the hopper, and when the coal reaches a certain level in the bin, it causes the indicator to function, thus closing an electric circuit which, in addition to lighting a signal lamp on the control board, trips a latch on the switching valve and allows it to close. A similar level indicator is used at the bottom of the hopper to indicate when the coal is below a certain point. A general arrangement of this complete system is illustrated in Fig. 15.

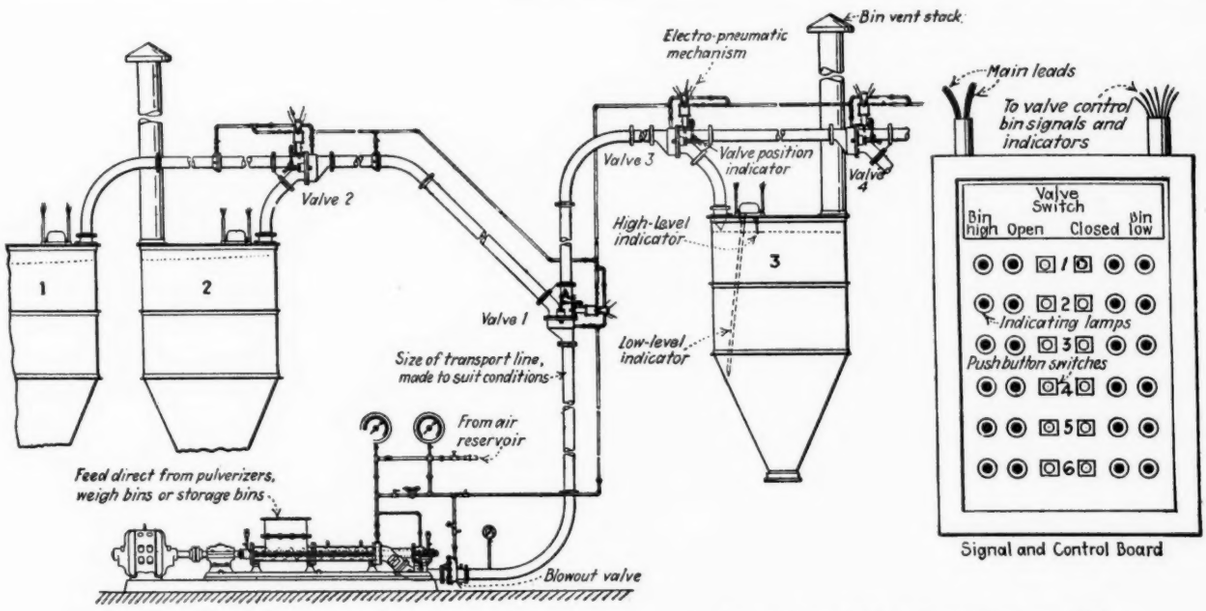


Fig. 15—General arrangement of Fuller-Kinyon conveying system with enlarged view of signal and control board

In the system shown at Fig. 4 and illustrated more

fully in Fig. 15, the positive feature of the mechanical and air conveying systems have been combined and provide a unit especially adapted to conveying the fuel long distances. This system combined the mechanical action of a screw with the fluidizing properties of air to impart motion to the fuel. The system consists essentially of a motor-driven worm pump the function of which is to start the mass in motion, a source of compressed-air supply and a pipe through which the material flows.

The screw of the pump revolves in a closed casing and is mounted on an extension shaft that passes through packing boxes at each end of the casing and is supported by outboard bearings.

The pulverized fuel is fed from the overhead hopper or weigh bin into the pump hopper and is carried by the screw through the barrel to the discharge end, where it is aërated by a number of small volume streams of compressed air at moderate pressure, and this changes the nature of the material from a compact mass to a

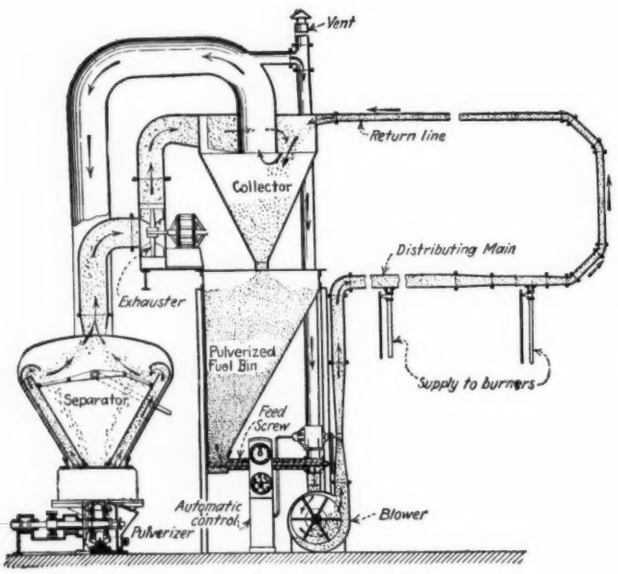


Fig. 16—General arrangement of typical circulating system

semi-fluid, in which state it is carried to the discharge end of the transport line.

The conveying line is built of ordinary wrought iron or steel pipe, the diameter depending on the capacities desired, the predominating sizes varying between 3 and 5 in. in diameter. The line may be made to supply any number of bins, as indicated in Fig. 15, by locating distributing valves at certain points in the line.

Distributing Valves Are Electro-Pneumatically Operated

The distributing valves (see Fig. 6) are of the disk, multiple-discharge-port type, electro-pneumatically operated and remotely controlled from a signal and control board conveniently located. An enlarged view of the board is shown at the right in Fig. 15.

The disk of the distributing valve is operated by means of two air cylinders, the air supply to which is regulated by solenoid operated valves controlled from the switchboard. On the outer end of the disk spindle is mounted a mercoid switch, and as the disk swings from one position to the other, the switch is revolved a certain amount and in each extreme position it closes an electric circuit which lights a signal lamp on the board, thus indicating to the operator whether the flow is to the main or branch line leading to a fuel bin.

Additional attachments used with this system, which make it practically automatic, are the material level indicators (see Figs. 5 and 16) that are mounted in each bin. The function of these is not only to indicate the high or low level of the material in the bin, but to control the operation of the distributing valves automatically.

As the incoming material raises the level in the bin, the paddle *A* is deflected from the vertical position and this causes the mercoid switch to function and operate the corresponding distributing valves. In a full automatic system a low-level indicator is also employed, which functions in the same way but reverses the operation.

Where it is desired to weigh the coal delivered to any part of the system, a weigh bin is suspended from a scale beam above the pump, the weight being registered on a beam or dial conveniently located. In this case a flexible connection is provided between the bin and the pump.

This system is particularly adapted for transporting coal long distances. In recent tests conducted by the manufacturer, pulverized coal was successfully conveyed a distance of 5,400 ft. through a 5-in. pipe. The quantity of air required to aërate the coal with this system is comparatively small, being around 6 cu.ft. per ton. The small volume of air used makes it possible to discharge the fuel directly to the bin without the use of a cyclone collector. The power required to operate the pump ranges between 1 and 2 kw.-hr. per ton of coal conveyed.

Direct Conveying System

Although the system shown in Fig. 16 has been applied to boilers only in a limited way and is distinctly different from the systems described in the foregoing, it is a typical illustration of the conveying method used extensively to supply the pulverized fuel to metallurgical furnaces and is of sufficient general interest to warrant a brief description.

In this system the transport of the coal is effected entirely by the motive power of a high-pressure blower. The pulverized coal is delivered by the exhauster from the vacuum separator of the pulverizer to the cyclone collector, from which it falls by gravity to the pulverized-coal bin.

The coal is withdrawn from the bottom of the bin by a feed screw and delivered to the suction side of a high-pressure blower. From the blower the coal, mixed with a relative proportion of air, is discharged into the distributing main, from which connections are made to the several furnaces, the remaining coal and air not used at the furnaces being returned to the cyclone collector. The amount of air mixed with the coal in the distributing main is about one-third the total quantity needed for combustion, or approximately 40 cu.ft. per pound of coal.

The unit system of firing also comes under the general heading of direct systems, as the fuel, mixed with from 75 to 100 per cent of the air required for combustion, is delivered directly from the pulverizer to the furnace by a fan incorporated in the body of the pulverizer or independently driven.

Developments in Steam-Turbine Field*

By E. H. BROWN
Engineer, Steam Turbine Department, Allis-Chalmers Manufacturing Co.

The steam turbine from its inception in 1884, with particular reference to recent developments in American and European practice, such as the general application of stage heating, use of high pressures with re-superheating, and improvements designed to give high efficiency at moderate peripheral velocities for the rotating parts.

IN THE development of the multi-stage steam turbine and suitable high-speed generators for direct connection to it, the pioneer period was from about 1884 to 1900. By 1884 Dr. DeLaval had developed an extremely high-speed single-stage impulse type of turbine which, however, was not applied to the generation of electricity. In that year Charles A. Parsons put into service the first multi-stage turbine directly connected to a direct-current generator, both turbine and generator operating at speeds up to 18,000 r.p.m. and having an output of 6 electrical horsepower. This pioneer turbo-generator was governed by a combined pneumatic and electrical regulator, the pneumatic feature being responsive to the change in air pressure generated by a fan when the speed changed and the electrical connection acting in response to the load demand on the generator.

Between 1884 and 1899 there was produced by Mr. Parsons a total capacity of 15,000 kw. in directly connected turbo-generator units. In 1900 two 1,000-kw. turbines were built for direct connection to 4,000-volt, 80 per cent power factor, 50-cycle alternators, both turbine and generator operating at 1,500 r.p.m. These units, built in the Parsons works in Newcastle-on-Tyne, England, were installed in the municipal plant of the City of Elberfeld, Germany. They were supplied with steam at about 145 lb. gage pressure, superheated about 90 deg. F., and operated condensing. The successful operating record of these turbines, together with publication of the results of the elaborate tests to which they were subjected, directed the attention of the engineers of the world to the subject of steam turbines in general. There was a concurrent development in this country by the Westinghouse interests which dated from their taking a license under Mr. Parsons' patents in the early 90's and their installation of a 1,000-kw. turbine in a commercial American plant at about the same time that the Elberfeld machines were put in service.

These pioneer turbo-alternators were put into service for conditions of steam pressure, temperature and vacuum corresponding in general to those prevalent at that time for reciprocating steam engines. It was appreciated that the turbine would have advantages in utilizing high steam pressure, high steam temperature and especially high vacuum. The rapid development in the steam-turbine field following these early installations was accomplished by an effort to increase the steam pressure, temperature and vacuum conditions in power generating stations. However, there were modifying influences connected with the rapid development in the machines themselves and in the rapid growth of the industry, which kept the operating conditions within what can be termed conservative values for the next fifteen years, or until about 1915.

During this period there had been a steady elimination of the unsound development that was manifested by the application of turbine designs based on the use of a small number of stages and consequent loss in efficiency. At about this time all the American turbines of high efficiency in large central-station sizes were available in designs involving the use of reduced diameters for that section of the machine subjected to the highest steam pressures and temperatures. It is significant to notice that this was accompanied by a development for new stations in the use of higher pressures and temperatures, the pressure being stepped up to 300 lb. gage and the temperature to over 600 deg. F. There was also a concurrent development in providing turbines with sufficient areas at the exhaust end to take full advantage of the large volume of steam resulting from the employment of normal vacuums as high as 1 in. of mercury, absolute. The period between 1915 and 1920 was occupied in general in improving the designs of turbines that had been brought out for application to the increased pressure and temperature conditions. In a sense this was a critical period for the large steam turbine because of the numerous failures that occurred in the large central stations of the country. No doubt it had a marked effect on turbine and power-plant development in general, and the experience gained as a result of the turbine troubles, probably still serves as the chief guide in current turbine designing.

Between 1920 and the present time the application of the turbine has centered around stations employing steam pressures ranging from 300 to 375 lb. gage and steam temperatures ranging from 650 to 725 deg. F. Practically all the turbines applied in this field are built, to a greater or lesser extent, with smaller diameters in the high-pressure, high-temperature section. There have been developed two distinct principles for providing sufficient area in the exhaust end of a single-cylinder large-capacity unit. It will be appreciated that high velocities resulting from insufficient area in the last row of turbine blades or in any part of the exhaust casing results in a loss in efficiency.

One of the two principles of design mentioned has been featured by concentration on the use of extremely high speeds (over 850 ft. per sec.) together with blades of extreme length for providing the necessary exhaust areas. The other principle is characterized by the more conservative policy of limiting the maximum speed of the rotating parts to a value of not over 750 ft. per sec. and providing the necessary exhaust area by a double set of moderate length blades exhausting into a single exhaust casing.

Recent developments in European turbine design have

*Paper presented at the second annual convention of the Wisconsin Utilities Association in Milwaukee.

centered first in the problems connected with the provision of sufficient exhaust area. The difficulties experienced there with turbines having rotative speeds of over 850 ft. per sec. also led to the development of arrangements that would eliminate this requirement of high blade speeds by providing two or more rows of exhaust blades. In Europe, as in America, turbines designed with a single row of exhaust blades of extreme length and high speed are still current for machines of large capacity in a single cylinder and are subject, in both places, to the same intensive study as to means for overcoming the resulting tendency to be sensitive to vibratory action in either or both the blade-carrying disk or wheel and the blades themselves.

Continental European turbine practice developed a type of large constant-diameter machine for central-station work, which has found application in their after-war power plants under steam pressures ranging up to 350 lb. gage and temperatures up to 700 deg. F. Their development of the large-diameter turbine without a reduction in diameter for the high-pressure, high-temperature initial stages has made an efficient machine of relatively few stages when compared with American turbines. Their turbines of this design have, however, subjected parts of the machine of large dimensions to heavy centrifugal stresses and to an extreme temperature range. In Continental Europe this development has been reflected in some of the devices and arrangements that have been proposed for utilizing the higher range of pressures, namely, from 500 to 600 lb. gage and higher.

In both American and European practice the development in economy in large central stations since the war period had led to a careful study of the gain to be had from the extraction of steam from intermediate stages of steam turbines, for the purpose, primarily, of heating feed water and preheating of air supplied the boiler furnaces. This principle of extracting steam from a prime mover had been applied in years past, especially in that branch of the reciprocating-engine field represented by water works and air-compressor practice. The economy to be realized from the stage extraction of steam had been demonstrated in the reciprocating engine field.

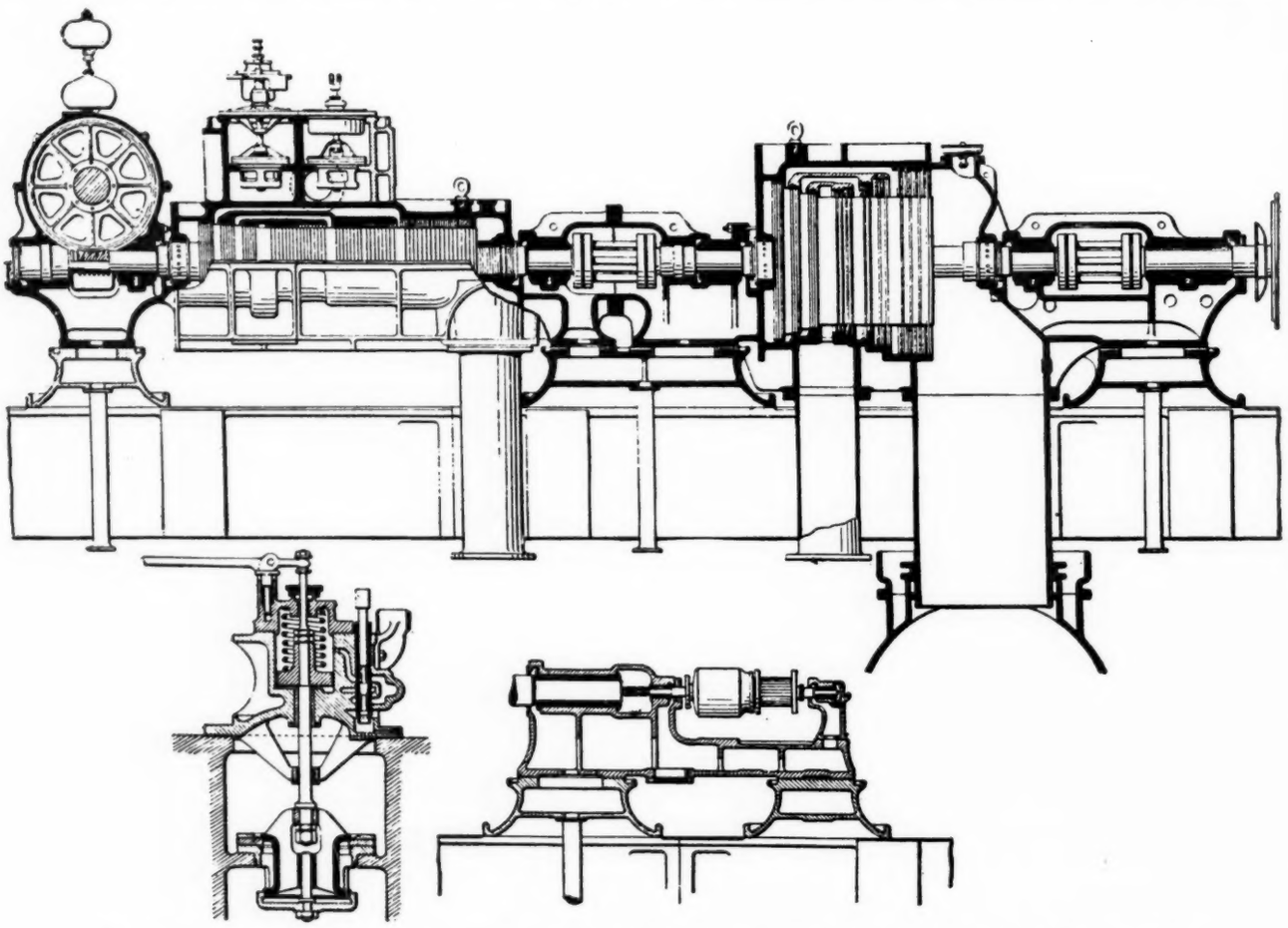


Fig. 1—First turbo-alternator of major size, 1,000 kw. Parsons machine, built in 1900 for city of Elberfeld, Germany

This installation together with its operating record and economy established the steam turbine in the steam-power field.

Following the attention given it by the central-station engineers of the country, numerous applications were made, involving the use of steam extracted from as many as four different stages in the turbine. It appears, in general, that the stage heating of feed water has had a profound effect on the question of auxiliary drive and economizer practice in the stations that are now being designed and constructed. It has resulted in a gain in economy of appreciable magnitude combined with a self-regulating method of controlling the temperature of the feed water.

All these things have been accomplished without a

major alteration in the principles of the turbines and with considerable advantage to the turbine designer. This advantage results from the marked reduction in the volume of steam for which area has to be provided in the last row of turbine blades. It is a feature which can be regarded as having been a latent possibility in practically every high-efficiency turbine and which had not been utilized probably for the reason that fuel costs did not warrant it. It is a matter which concerns the turbine primarily, but which has been accommodated without fundamental changes in the trend of turbine development and which represents one of the greatest recent steps in improving the economy of the power-station engine room.

Designs of turbines have now been accommodated to nearly standard arrangements for the extraction of steam for feed-water heating, standard turbines in sizes as small as 500 kw. having been installed with arrangements for the use of this economical process. Turbine builders have co-operated to the full extent with the power-station designer in meeting the requirements, and the detail internal proportioning of the major sizes of turbines is carried out to make them more precisely suitable for the extraction of large quantities of steam.

At the same time that the extraction of steam from turbines was being studied, the resuperheating of steam, an old suggestion, was being given the most careful study. However, due to its greater effect on the turbine and on the boiler room and piping arrangement, it has been much slower in finding application. It was developed during the study that was given to the subject of the reheating of steam that the economy to be gained would not be sufficient to warrant its introduction for stations with initial steam pressures of less than 500 lb. gage. Further, it was established fairly definitely by both turbine engineers and power-plant designers that the pressure at which the steam should be withdrawn from the turbine and resuperheated had a marked effect on the gain to be expected.

In general it can be said that for a station of 500 lb. gage pressure and 700 deg. F. initial steam temperature, the steam would be expanded to a pressure of about 120 to 140 lb. gage and returned to re-superheating elements in the boiler setting in which its temperature would be raised again to 700 deg. F. The resuperheated steam would be returned to the turbine equipment and expanded to a condenser pressure of 1 in. of mercury, absolute. The resuperheating would, from considerations of efficiency, take place just before the steam had reached the dew-point above which it, of course, contains no moisture.

The effect of the application of reheating of the steam on the design of turbines was of major importance. There are three pioneer power stations in this field, one in England and two in America. The English plant has been in service for some years, and the two American plants are well under construction. The former plant and one of the American plants employ

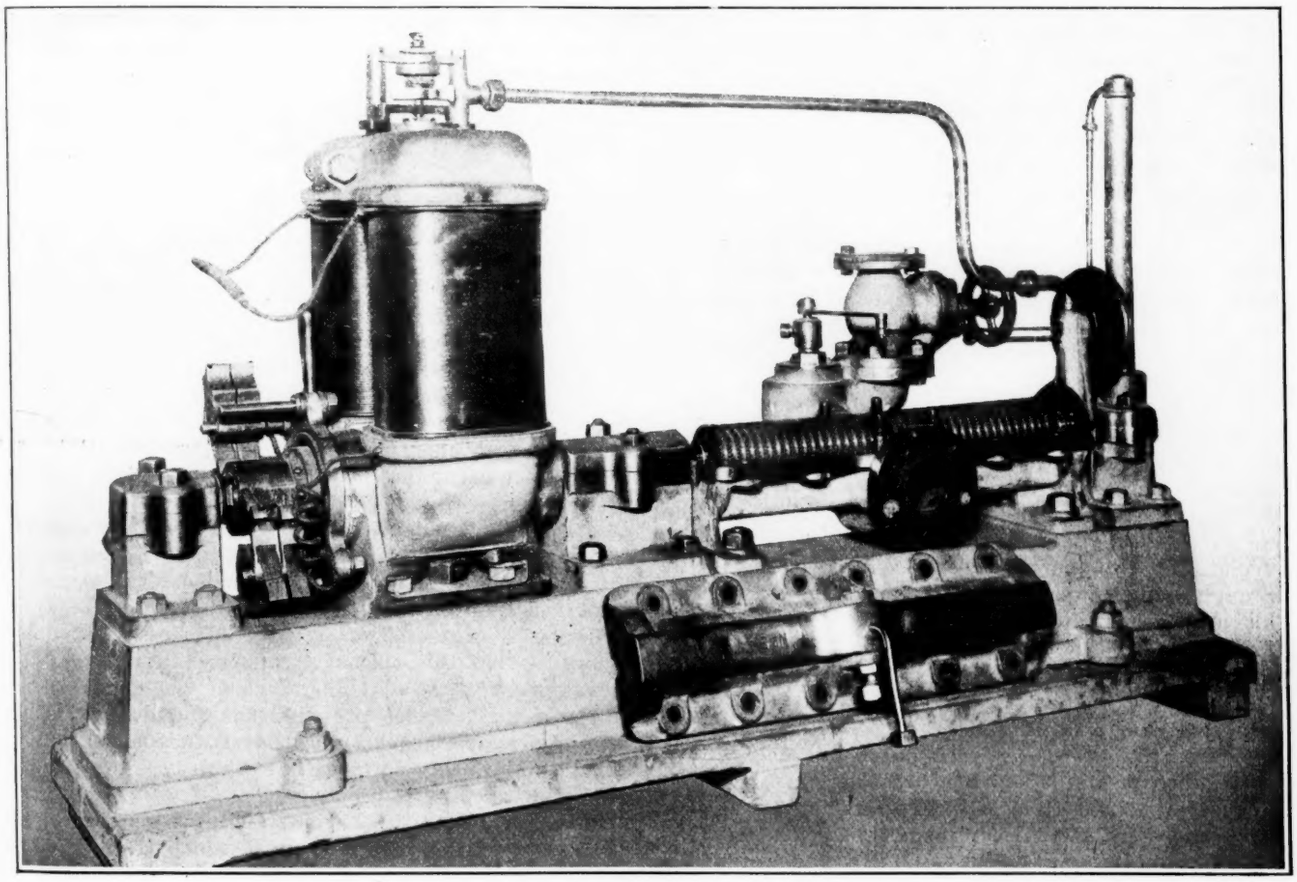


Fig. 2—No. 5 Parsons turbo-generator

In detail of design and construction this turbine is practically a duplicate of the World's first turbo-generator built and operated by Mr. Parsons in 1884, and now preserved in the South Kensington Museum in London. The turbine shown in the photograph was built about the same time. It is of the double-flow type, has been in commercial service for many years and is now on exhibition at the works of the Allis-Chalmers Manufacturing Co., in Milwaukee.

turbines of the multi-cylinder type, turbines of both the reaction and the impulse principle of design being represented. The other American plant will employ turbines of the single-cylinder type, the steam being withdrawn from, resuperheated and readmitted to the turbine cylinder. In general, it can be said that the turbine designer has taken full advantage of the high-pressure reheating type of station to employ small diameters for the initial high-pressure stages of the turbines. This type of station most probably will find its greatest application in the large centers of population in the country, for the writer is not aware of any study being given to its commercial application for the smaller or medium-sized plants.

The Brun Type and Its Effect on Continental Practice

In Continental Europe the study of this problem of employing pressures up to 500 lb. gage with resuperheating of steam has led to the development of a turbine with a great number of stages built in its high-pressure end on the impulse or Rateau principle and made to employ, in all cases, two or more cylinders. This turbine, which has been developed by a concern in Czechoslovakia, the Erste Brun Company, employs blades or buckets of extremely small height together with very small clearances. So far as is known, it is not yet in service in a plant of the type under discussion, but the turbine has demonstrated excellent efficiency in the high-pressure section of the machine when used for more normal service.

Introduction of this turbine has had a notable effect upon the trend of Continental practice, especially as it related to the large constant-diameter type of machine developed there. The builders of the constant-diameter, short-shaft Continental turbine had contemplated the use of small high-pressure turbines running at high revolutions per minute and connected to the main unit through reduction gears. It remains to be seen whether this arrangement will succumb to the Brun type of turbine.

Generating Steam at 1,200 Pounds Gage

In some cases, in this country, power-station engineers have undertaken the installation of plants with a limited amount of equipment generating steam at 1,200 lb. gage pressure. It is generally considered that this represents more a study in steam generation and that the turbines that have been proposed and are under construction for this pressure, do not represent an efficient solution of the problem in turbine design connected with such pressures. The turbines for these plants are uniformly of the multi-velocity stage of limited efficiency and represent a development that has been abandoned steadily under the pressure for high economy with normal steam conditions.

Practically all of the turbine developments mentioned except those connected with resuperheating and extremely high-pressure plants apply to the sizes of turbines used in communities of 30,000 inhabitants or more. These developments include, in general, an increase in the number of stages employed, an abandonment of the more inefficient types of turbine blading, the employment of turbines smaller in diameter in the high-pressure section and the application of stage heating of feed water. There has been, in addition, a tendency toward the acceptance of certain principles of detail construction. Included in this is the abandonment of the contact or carbon type of packing for the use of thin-edged close-clearance labyrinth arrangements. As mentioned, there has been, in general, an increase in the number of stages for all sizes of high-efficiency turbines. The smaller turbine has been made suitable for high steam pressures and temperatures, and its development has included provision for minimizing the exhaust losses.

There has been a development in the detail arrangement and adjustment of turbines which has found application in Europe and America and which, from a power-plant operator's point of view, has proved most effective in adding to the reliability of the turbine. It has been mentioned that there has been a general acceptance of the principle of providing thin edges of close clearance in all designs and types of machines. It is also now generally understood by practically all turbine users that close clearances are inherent in steam turbines and that there is no type of design of multi-stage machine that can be constructed without micrometer clearances between rotating and stationary parts.

Development of Principles of Clearance

The Parsons Company has developed and applied the principle of having clearances in the high-pressure high-temperature section of the turbine maintained in an axial direction as contrasted with radial clearances which have been common in the past to all designs and types. Further, the company has added the refinement of making it possible for the turbine operator to increase these clearances during starting periods or at other times of abnormal operation. This provision for readily increasing the clearance is of the utmost importance when it is considered that in the majority of cases where accidents occur from contact between rotating and stationary parts, they take place during the time that the turbine is being started. This development has been an aid to the turbine designer in constructing a machine of higher efficiency with the assurance that this efficiency can be obtained with an improvement in the reliability factor. The development of the axial clearance principle has found application in America and has been developed independently on Continental Europe in the Erste Brun type of turbine previously mentioned.

It can be said that the outstanding recent developments have been the general application of stage heating, even though this application involved no major changes in the principles of turbine design, and the development of turbine designs of high efficiency at moderate peripheral velocities for the rotating parts, together with the improvement of designs subject to destructive vibratory characteristics.

At the recent meeting of the National Association of Purchasing Agents in Boston, Mass., it was pointed out that the "production possibilities" are about 50 per cent in excess of the soft-coal-consumption "possibilities." In spite of this fact little may be expected in the way of further price concession, it was pointed out. Mining and marketing of coal is still hampered by wasteful and old-fashioned methods in spite of the efforts and recommendations of the United States Coal Commission and its plan to correct the evil. Congress has shelved the coal problem.

Another Efficiency

THERE has been great need of some standard method of stating efficiencies on a dollar-and-cents basis. Engineers are so familiar with the various expressions for thermal efficiency that they are in constant danger of drawing commercial conclusions from comparisons made on this basis alone. The grading of boiler performances on the thermal-efficiency basis or of over-all plant performances on the basis of B.t.u. consumed per kilowatt-hour is common. While those making the comparisons would admit that such figures, by themselves, prove nothing as to the relative economic performance of power plants, the mere fact that such comparisons are frequently made without divulging cost figures inevitably tends to create false impressions. If the bald statement is made that one plant consumes 20,000 B.t.u. per kilowatt-hour while another takes 18,000 B.t.u., the average listener or reader is likely to conclude that the second represents better engineering practice. Such a conclusion is entirely unjustified. If the engineer's attention is to be effectively directed to commercial efficiencies rather than mere thermal efficiencies, he must be given an expression for the former as simple and definite as those he possesses for the latter.

This need seems to have been met by Charles E. Lucke in his paper, "The Value of Efficiency in Transforming and Distributing Energy," recently delivered before several branches of the A.S.M.E. and abstracted in this issue of *Power*. This paper is a masterly analysis, step by step, of the factors that build up the cost of the energy of coal in the mine, oil in the well or water in the river to the enormously higher cost of the energy as it reaches the ultimate consumer. Professor Lucke has devised a simple formula for commercial efficiency that can be applied to each stage of this process, the over-all efficiency being the product of the efficiencies of the individual steps.

The commercial efficiency of any process is defined as the ratio of the cost (in cents per million B.t.u.) of the input energy to that of the output energy. The expression developed gives this efficiency as the ratio of the energy efficiency E (expressed as a fraction) to one plus the product of E by the ratio of the sum of the operating and investment costs of the process per unit of output to the unit cost of the input energy.

In the imaginary case where the operating and investment charges are zero, this expression reduces to E. It is evident, for example, that if no operating or investment charges were involved in the operation of a boiler, the commercial efficiency of the steam-making process would be the same as the over-all boiler efficiency, so that for a boiler of sixty per cent efficiency the cost per million B.t.u. of coal energy in the stoker hopper would be sixty per cent of the cost per million B.t.u. of the energy in the delivered steam.

If the cost of the coal input were 30 cents per million B.t.u., the steam output would cost $30 \div 0.6 = 50$ cents per million B.t.u. Operating and maintenance charges totaling 20 cents per million B.t.u. of output would raise the total output unit cost to 70 cents and give a commercial efficiency of $30 \div 70 = 42.9$ per cent. Another boiler using the same fuel with seventy per cent thermal efficiency, but with operating and investment charges of 30 cents per unit of output, would have a commercial efficiency of 41.2 per cent, actually inferior to that of the thermally less efficient boiler. These results may be checked by the formula.

The general use of this formula by engineers in comparing various types of equipment and methods of operation would doubtless do much to get them out of the rut of thermal-efficiency comparisons.

New England's Dilemma

CERTAIN parts of New England, being favored with water powers that were easily developed within easy distances of transportation and labor supply, attracted industries early in the development of this country. When the water powers were no longer sufficient to meet the needs of these industries, cheap fuel in steam plants supplied the deficiency and water power became of less importance. In fact, many of the old water-power developments in the less favorable industrial situations were abandoned for steam plants in localities better suited to industrial expansion. Within the last few years the rising cost of fuel, the uncertainty of obtaining it and the increased cost of labor have seriously endangered the industrial advantages that southern New England has enjoyed for many years, and she is now faced with the problem of not only attracting industries to establish within her border, but also holding those that are already there.

Eastern Massachusetts, southern New Hampshire and Rhode Island contain a large percentage of the industries of the New England States. About seventy-five per cent of the approximately one million horsepower of undeveloped water power of the New England States is in Maine, but that state has a law prohibiting the exportation of power. Southeastern New England needs the water power from Maine or some other source to assist in relieving the fuel situation and to retain her industries, while Maine wishes to attract industries that are located elsewhere to utilize her water powers at home. As a result of this, undoubtedly both sections will suffer. Maine cannot expect to obtain to any great extent such industries as have grown up on a large scale in southeastern New England, when much more favorable locations can be found elsewhere, and where these industries are already locating on a large scale.

Industries have grown up in sections that have favorable conditions, such as nearness to raw materials and markets, labor supply, favorable climatic conditions,

good transportation, cheap power and fuel. Under modern conditions some of these factors no longer control the location of industries. It is no longer necessary to build near water-power sites to obtain cheap power except in a few industries in which the cost of power represents a considerable portion of the production costs. So it is in New England; if water power cannot be obtained from the State of Maine, it can undoubtedly be procured from Quebec, which has some five million undeveloped horsepower, much of which is almost as close to New England's industries located around Boston as is a large percentage of the water powers of Maine.

It is to their Canadian neighbors that the Associated Industries of Massachusetts are already turning their attention. One of the chief problems that confront New England is a fuel supply which involves not only the rising costs but difficulty in obtaining it at any price in case of disturbance in the fuel industry. Industries that are now in Massachusetts and Rhode Island would find themselves in a much worse position in Maine, with regard to both fuel supply and transportation. There are certain industries that by natural environments belong to a state, and these Maine may well cultivate and encourage. At the same time there is much to be gained in co-operating with her neighbor to build up other industrial centers as near home as possible, as these will contribute materially to her own development.

Limitation of Relations Between Employer and Employee

INDUSTRIAL democracy is a catchword. The underlying principle, however, in spite of its varied criticisms is being practically employed today with success in many instances.

There have been periods in the histories of countries where the individual workers largely owned their own tools, functioning as fairly independent individuals. In the present complex relations of society a comparatively small number find it possible to exist in a like manner, as exemplified in agriculture, fisheries, merchandising, etc.

Where small manufacturing or power plants formerly existed, larger factories or power systems now operate. It has been found that the close relations between the employer and workman of the small group must be simulated in some manner in the greater industrial development. Delegating authority tends to weaken the structure of mutual understanding on which co-operation and eventual success depend.

As pointed out by Dean Dexter S. Kimball of Cornell, in an address at the recent convention of the National District Heating Association, the restoring of proper industrial relations hinges largely on an appreciation of the limitations involved.

It is of great importance that higher executives keep in close touch with the workingman. Elected representations of operatives making it possible for the management and the wage earner to meet face to face, are of inestimable benefit. Large corporations are devising ways for extending the touch of human relationship, otherwise lost as a result of growth and physical separation.

Radical or indiscriminate extension of such representative plans, however, are likely to be of little material benefit. Where the workman's share includes an appreciable voice in management, certain limitations should be observed. Successful operation of a factory, power plant or organization of any kind depends largely on trained intelligence. The dictates of a designing engineer are normally of more value in making some decisions than that of the entire body of working men, no one of whom is a competent designer. Many questions of finance belong to a finance department only, as those of selling to a sales manager.

In deciding business or other questions, it must be remembered that intelligence essentially is not elective. The workers' council should perform definite functions, but if given authority for action beyond its reasonable sphere of ability, the desired ends will be forfeited.

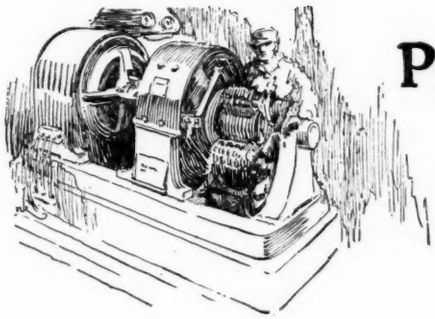
Credit for Economies

GOOD engineering brings about untold savings every year in the operation of power plants throughout the country, but often too little permanent credit is given to those responsible for such economies in industrial and utility organizations.

It is common for an engineering staff and its supporting rank and file in the operating departments to achieve a notable improvement in plant efficiency, to report the gains obtained in the campaign against waste, and then to have the owner or his executive representative establish the new standard of efficiency for all time to come, leaving room, of course, for still further improvements. Such procedure is entirely proper, but where the shoe pinches is the speed with which many owners and executives manage to forget these accomplishments and their significance when questions of promotion or transfer arise or when the technical staff urges appropriations for betterment work.

It is undeniable that a source of waste once stopped inevitably becomes plant history. The world is too busy and faces too many urgent problems to spend much time poring over losses that might have occurred if some able engineer and his associates had not put in their effective work and shown the way to avoid such wastes in the future. But it should *not* be too busy to record each major achievement of this kind in the plant file or in personnel service folders, so that a rapid checking of the plant-efficiency history can be done at any time afterward. Due credit to the engineer rests upon the quality of his service, and the accurate appraisal of that service over a term of years may well be established by suitable records of economies gained in the systematic administration of his plant responsibilities.

"Why should not the railroads of this country store twenty million tons of coal every summer?" This question was advanced by F. G. Tryon, of the Geological Survey, at a recent meeting of the International Railway Fuel Association. As one feature of the solution of the coal-transportation problem it has merit. It will not, however, be expedient for executives of plants and industries to trust to the thought that since railroads are storing during the summer, there will be coal a-plenty for them when the cold weather arrives. Everybody should put in a supply during the summer, when transportation facilities are available, prices reasonable, and workers who would otherwise be idle, given employment.



Practical Ideas *from* Practical Men

Improvised Flue Cleaner

Some time ago I had an urgent use for a flue scraper to clean the tubes on a small vertical boiler used for thawing in an ice plant.

As no scraper was available, I made a serviceable cleaner by stringing a number of washers and nuts on a rope. I found some washers the size of the tubes and strung these on a piece of sash cord with nuts between them, putting on seven washers in all. On top of these I placed a small length of pipe for a weight. I was forced to use rope on account of the low headroom above the boiler, but a satisfactory job was done.

R. G. SUMMERS.

Geneva, N. Y.

Why Does the Temperature of the Furnace Walls Increase After Fires Are Extinguished?

I recently visited a steam plant, where some interesting brickwork temperature observations have been made, and I would appreciate an explanation from readers of *Power* of the following phenomena:

The boilers are 500 sq.ft. horizontal water-tube, oil fired under the mud drum, and set with 16 ft. high furnaces. The front wall, opposite the burners, is built up of 13½ in. of firebrick backed by 8 in. of red brick. A mortar joint in this wall has been scratched out for a depth of about ¾ in. and a glass-stem thermometer, packed in asbestos, has been placed in it so as to have 3 in. of the stem covered, the rest being exposed to room temperature. A long series of temperature records have been taken from the thermometer.

The plant is operated 24 hours a day with a shutdown of 20 hours over the week end. The boiler rating averages 125 to 160 per cent for the week, with peaks of 200 per cent. After a complete shutdown—that is, with furnaces cold—temperatures will gradually build up until the fourth day, when a terminal temperature of about 310 deg. will have been reached. After the fires are extinguished and the dampers tightly closed, this terminal temperature will be maintained for a period of from 12 to 60 hours. There will then be an increase of temperature at an average rate of about 5 deg. per hour until a maximum of 350 deg. has been reached. The temperature will then decrease at a rate of about 6 deg. an hour.

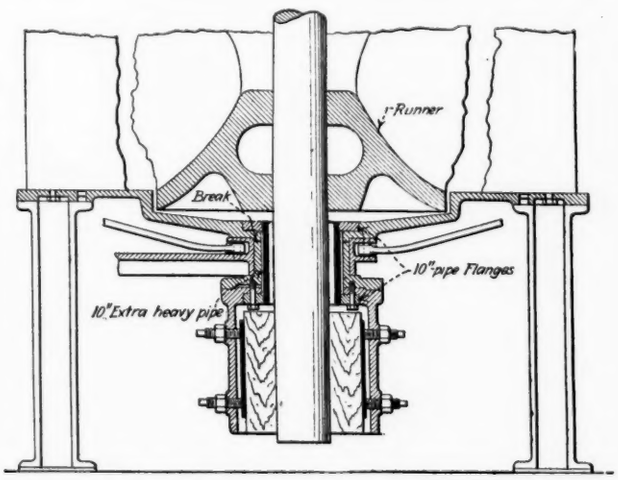
It is assumed that the variation in the length of time that the temperature is maintained after a shutdown is due to a variable damper leakage, wind, etc., but the rise in temperature has not yet been satisfactorily accounted for. A pressure of 0.35 in. is maintained in the furnaces, and it has been suggested that air infiltration keeps the terminal temperature down and that the rise in temperature is due to the cutting off of the draft with the resulting decrease in infiltration. The walls are new and in good condition, but they are not reinforced by any airproof coating. It is to be noted that the temperature rise takes place independent of the total time required for the cooling of the setting.

Powell River, B. C., Canada. M. S. GEREND.

Unusual Repair to Hydraulic Turbine

We recently made a repair to one of our waterwheels that is rather unusual and may be of interest to other readers.

The particular wheel on which the repair was made is a twin vertical turbine, with 38-in. runners direct connected to a 250-kw. generator. This machine is in continuous operation except when shut down for inspection and repairs. Recently, without any apparent cause



How repairs were made with two pipe flanges and 10-in. extra heavy nipple

the turbine began to pound violently. The operator shut the machine down immediately, and upon inspection it was found that the lower crown-sheet casting was broken as indicated in the illustration. This collar supports the lower steady bearing and also the governor mechanism controlling the gates.

Our first thought was to weld this collar back to the crown sheet, and as the owner of one of our local machine shops guaranteed the job to hold, we turned the welding over to him. He used an electric welding machine. After cooling over night, the collar was found in the bottom of the pit.

In the meantime we had ordered a new part from the factory, but were informed that this order was special and would take considerable time to cast and

machine for shipment. By this machine being out of commission, we were incurring a loss of water amounting to between $130 and $140 a day, and it was essential that some sort of repair be made to utilize the water that was going to waste.

The following was finally decided upon: The crown-sheet casting was recessed and machined to receive a 10-in. flange. The lower part of the collar and the top part of the steady-bearing casting were also recessed to take a similar flange, and these two flanges were screwed onto a piece of 10-in. extra-heavy pipe. The bottom casting, or steady bearing, was bolted with stud bolts through the lower flange. The wheel was reassembled and put into operation and after a week's run was taken down for inspection. Everything was found to be in first-class condition and apparently as rigid and strong as the original casting.

Manhattan, Kansas. ARTHUR GROESBECK.

Checking Three-Phase Wattmeter Connections

When it came time to connect up the polyphase watt-hour meters at each end of a 14-mile line, it was found that each meter had eight binding posts. The power was stepped up from 2,300 volts to 13,200 volts at the generator end of the line and was again stepped down to 2,300 volts at the receiving end, so that current and potential transformers had to be used with the watt-hour meters.

With this type of watt-hour meter on loads having a power factor less than unity and greater than 0.50, it is possible, by using both elements, to obtain twenty combination of connections which will give forward rotation of the disk, but only four of these combinations will give accurate registration. Therefore it is easy to see how it is possible to have difficulty with watt-hour meter connections if great care is not exercised in wiring. It

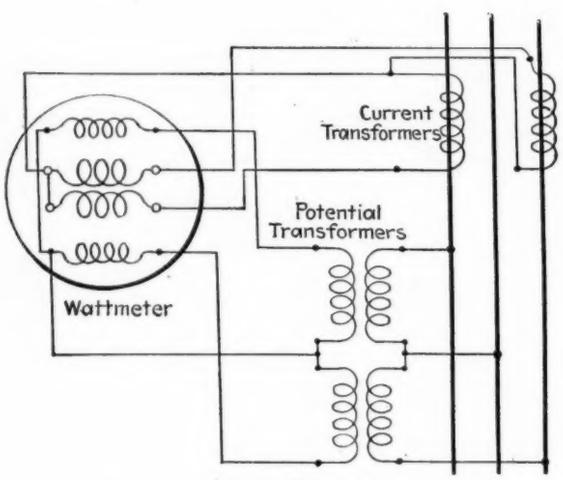


Fig. 1—Incorrect meter connections

is also true that forward rotation of the disk is not a proof that the meter is correctly wired.

The diagram, Fig. 1, shows how the meter connections had been made when the line was finished and the current turned on. Suspicion arose as to the behavior of the meters at each end of the line. Under some loads the meter at the receiving end would register more than the one at the generator end and vice versa. This was at first thought to be due to an unbalanced load, but to determine the real trouble, an investigation was made.

The first cause of trouble found was that the instrument transformers supplying the same element in the meter were connected to different phases; that is, the current transformers in one phase and a potential transformer in another phase were connected to the same meter element, as in Fig. 1. After this was corrected,

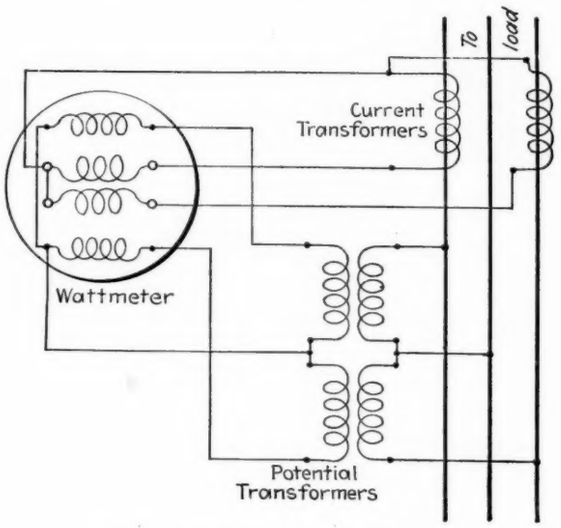


Fig. 2—Correct meter connections

things were still unsatisfactory. A closer investigation revealed that the current-transformer wiring was wrong, and it was changed from that in Fig. 1 to that in Fig. 2.

The company selling the energy was not yet satisfied, as it thought the losses between the two meters should not exceed 4 per cent, and the actual loss was running about 8 per cent. The current is transmitted 14 miles over No. 6 hard-drawn bare solid copper wire, and the step-up transformers are in a bank of three 50-kw. units each. The step-down transformers are the same size and number, totaling 150 kw. in each bank. Both banks are normally loaded.

The meters were watched under test during different periods of ten hours each and the one at the generator end of the line registered 823 kw.-hr., while the one at the receiving end registered 760. Next an effort was made to either prove or disprove the correctness of the 7.6 per cent loss. The power factor of the load was about 0.80, therefore the current equals $(150 \times 1{,}000) \div (13{,}200 \times 1.732 \times 0.80) = 8.2$ amperes per phase. A No. 6 hard-drawn copper wire has a resistance of 2.25 ohms per mile, and 14 miles would have $14 \times 2.25 = 31.5$ ohms for the total length of one wire.

The watts loss equals the square of the current times the resistance in ohms. For one wire the watts loss $= 8.2 \times 8.2 \times 31.5 = 2{,}118$, and for three lines the watts loss equals $3 \times 2{,}118 = 6{,}354$, or 6.35 kw. Reducing this to a percentage basis gives $(6.35 \div 150) \times 100 = 4.23$ per cent for the line. The step-up transformer bank has about 2 per cent loss and the step-down transformer bank about the same, making the total loss equal $4 + 2 + 2 = 8$ per cent. Therefore, the losses equalled about the difference in the meter readings, and everything checked up closely and has been running satisfactorily for over three years. V. K. STANLEY.

Ponca City, Okla.

Comments from Readers

Parsons Line

Referring to the article, "An International Puzzle," the April 1 issue, I have at various times obtained the same absurd result as those plotted for Lakeside. The point is that a regular or straight-line graph can represent the relations of two variables only when they are so related that a change in one produces a corresponding change in the other, that is, one variable must vary *directly* as the other. The Parsons line cannot, then, take account of the variation in efficiency at different percentages of boiler rating, and this I believe is the cause of all the trouble.

The points selected for Lakeside are all points of high rating (and low efficiency). H. Kriesinger has shown that above 170 per cent of rating the efficiency drops considerably with every relatively small increase of rating. Hence, when a line is passed through two plotted points, one of high rating and one of low rating and higher efficiency, it will be too steep and if continued will give the absurd result quoted.

Maldon, Essex, England. JAMES F. EDGELL.

Would It Pay To Install a New Engine?

In the May 20 issue C. F. Merriam asks for some practical criticism on an examination question. The problem called for a decision on the relative ultimate economy of two 150-kw. Diesel engines, the one already installed in the plant and the other a proposed replacement unit of higher economy.

From the data given, the annual cost with the old unit might be summarized as follows:

ANNUAL OPERATION COST OF OLD UNIT

Fixed charges, $46,000 × 16 per cent	$7,360.00
Attendance	7,500.00
Water and supplies	1,400.00
Fuel, 7,200 hr. × 150 kw. × 80 per cent × 0.68c.	5,875.20
Total cost of making 864,000 kw.-hr.	$22,135.20

Now consider the new unit that the *Y* Engine Co. is trying to sell on the basis of higher fuel economy. Fixed charges will be increased by 20 per cent of the additional $3,900 cost (since the old engine will be taken in part payment) or $780. Attendance cost will be $500 a year less, and water and supplies will remain at $1,400.

From the test results on the new unit it is shown that the fuel consumed per kilowatt-hour is 0.59 lb. It is also stated that the cost of the fuel is 7½ cents per gallon, weighing on the average 7½ lb., from which it follows that the fuel cost per kilowatt-hour is 0.59 cent.

The summation will then show:

ANNUAL COST OF NEW UNIT

Fixed charges, $7,360 plus 20 per cent of $3,900	$8,140.00
Attendance	7,000.00
Water and supplies	1,400.00
Fuel (864,000 × 0.59c.)	5,097.60
Total cost of making 864,000 kw.-hr.	$21,637.60

The total annual cost difference in favor of the new unit would apparently be $500. This, however, is based entirely on the assumption that the new unit would show its test fuel economy month in and month out under operating conditions. Test conditions, as is universally appreciated, are almost always extremely favorable ones, particularly with regard to load fluctuations which might affect economy.

I should say that the margin of only $500 a year was entirely too close to warrant a change as proposed.

Possibly the author also had in mind a criticism of the proposition as an examination question. I should say that it was a very fair question (that statement might admit of modification if we were told the class of work for which the applicant was being examined), in that it is a case any operating engineer might be asked to advise on. It also gives the man an opportunity to show his ability to distinguish between pertinent and irrelevant facts.

For instance, in the full paragraph of data quoted from the new unit test results, only one item—the fuel consumed per kilowatt-hour—is actually needed for the dollars and cents analysis of the proposal. The rest of the data given cannot even be used to determine how nearly the test approximated operating conditions, since the figures are given for uniform operation throughout the period of the test. W. J. RISLEY, JR.

Philadelphia, Pa.

Does One Lose Ammonia in Purging?

I should like the privilege of answering John Cassiday's query in *Power*, May 27, in reference to a non-condensable gas separator. We have a plant rated at 720 tons refrigerating capacity and have an apparatus of this kind in use. We feel that it is doing all that the manufacturers claim for it. Of course, there may be an impression derived from the builder's advertisement that is misleading; that is, that the separator will remove every ounce of non-condensable gas without loss of ammonia. One might take it that there is not supposed to be any ammonia in this non-condensable gas, but on second thought this would be impossible, as there is bound to be a certain amount of ammonia vapor that will not condense or separate, even at the low temperature and high pressure under which the separator works. Yet this vapor and considerable more would be mixed in with the air that is purged from the highest point of the condensers in the usual method of blowing off air.

We figure that we collect approximately ¼ to ½ gallon of ammonia liquid per hour, while air is blowing out of the pop valve at a good rate. We have had the apparatus in operation about ten or twelve days, but believe that we are practically rid of air now. To give a better idea of what the separator was doing, we made a connection from the pop valve and ran it into a large white bottle, three parts filled with water, and marked the water level on the bottle, so we could see if there was any ammonia absorbed by the water. Once in a while we would pass a lighted sulphur stick over the bottle when the pop valve was blowing, but

while air bubbles were rising very rapidly through the water, we could barely detect the usual cloudy smoke that comes from burning sulphur in ammonia fumes, so that to our mind loss of ammonia is very slight. In fact, this is what we understand to be non-condensable gas, which certainly could not be separated or condensed in the condenser.

We have not changed the water since we started using the outfit, and believe that there is probably 1 per cent of ammonia absorbed by the water. This apparatus is set up in the engine room, and when it is blowing hardest, we cannot smell ammonia except when close to the opening in the bottle, and it is then only very faint. Of course this is quite different from what we have been used to when blowing off air from condensers, and we are pleased with the outfit. We are certainly getting rid of air, with practically no loss of ammonia and without shutting our plant down.

Toronto, Canada. V. A. MADILL.

Where Should the Water Be Discharged in a Return-Tubular Boiler?

Although several answers and comments have appeared in reply to the question of R. E. Graves in the Jan. 29 issue, "Where Should the Water Be Discharged

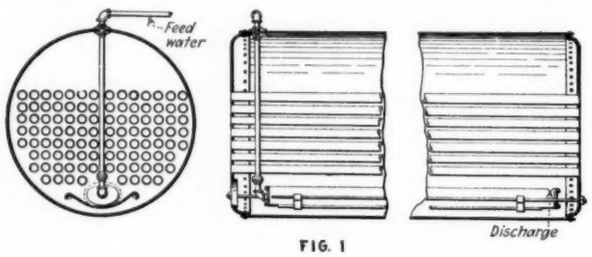


FIG. 1

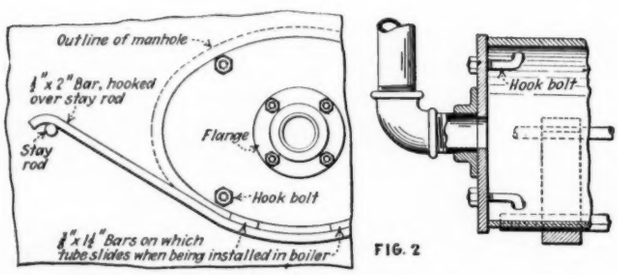

Outline of manhole
1" x 2" Bar, hooked over stay rod
Stay rod
Flange
Hook bolt
1" x 1½" Bars on which tube slides when being installed in boiler
Hook bolt

FIG. 2

Figs. 1 and 2—General arrangement of the tube boiler and details of construction

in a Return-Tubular Boiler," the following may still prove of interest.

In operating a number of 72-in. by 18-ft. horizontal return-tubular boilers using water carrying considerable scale-forming matter, the trouble from scaling and priming was considerably reduced by the following method:

The feed water was taken into the boiler either through the front head at the usual location or through the top of the shell near the front end, the connection being carried down the center between the tubes, as near the front head as was convenient, where it was connected by a flange union to a light sheet-iron tube which was supported between the tubes and the bottom of the boiler on a cradle resting on the through stays.

The tube was made 16 ft. long and as large in diameter as the manhole and stay rods would permit. It was constructed from No. 16 gage steel sheets riveted together. The ends were closed with sheets cut to the proper size and held in place with hook bolts.

Referring to the illustration, the inlet connection for the water was made by bolting a flange on the front head, through which the feed water entered, while a hole was cut in the top side of the tube at the rear end, for the discharge of the water to the boiler.

Owing to the volume of the tube the water remains in it until practically boiler temperature is reached before being set free in the boiler, the result being that much of the scale-forming matter is thrown down in the tube along with the mud, where it remains until the tube is removed and the boiler is cleaned.

The action in the tube is very similar to that in a feed-water purifier using live steam at boiler pressure to precipitate the impurities. On a two weeks' run as much as three to five cubic feet of mud and scale has been found in the tubes, while the boiler was practically clear.

When the tube is heavily loaded with mud and scale, a tackle may be required to remove it from the boiler, but once it is removed, very little cleaning of the boiler is necessary. Any scale that has baked onto the tube can be easily removed by pounding it lightly with a wooden block or hammer.

A tube of these general dimensions can be installed for about $60 a boiler, using the regular operating force to do the work. IRA A. BUTCHER.

Pittsburg, Kan.

An Examination Question

In reply to the question asked by Carroll F. Merriam, in *Power*, May 20, I submit the following computations as showing the relative costs of the two engines:

	Old Engine	New Engine
Fixed charges, at 16 per cent of $46,000	$7,360.00	$7,360.00
Additional, at 20 per cent of $3,900	.....	780.00
Attendance cost	7,500.00	7,000.00
Supplies	1,400.00	1,400.00
Fuel, both engines producing the same kw.-hr. per yr.	5,875.20	5,097.60
	$22,135.20	$21,637.60

The balance is $497.60 in favor of the new engine.

Referring to the test data, I find that the heat distribution does not balance. There are 3,415 B.t.u. in a kilowatt-hour, and the efficiency of the generator is given as 80 per cent, therefore the heat balance works out as follows:

Heat utilized, $\frac{184.32}{8} \times 3{,}440$ B.t.u.	786,816
Heat to cooling water, $11{,}487 \times (156 - 43)$	1,297,500
Heat to exhaust, $(1 + 18.2) \times 108.75\,(785 - 74) \times 24$	356,200
Total consumed	2,440,516
Total heat put into engine $108.75 \times 20{,}558$	2,230,000

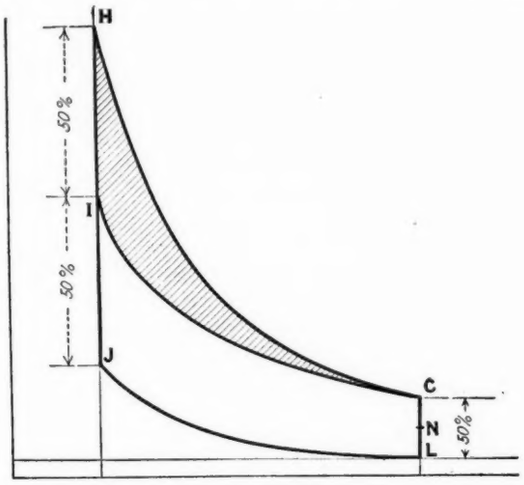
The data given make no allowance for the loss due to radiation and the friction loss in the engine, which will be about 20 per cent of the developed horsepower. Neither do the percentages check with those obtained in practice; the heat lost to the cooling water is far too much, the heat carried away by the exhaust is too little and the ratio of oil to air, 1 to 18.2, is too near to the theoretical ratio computed mathematically to be practical. The thermal efficiency, however, agrees closely with that obtained in engines of this class which, I take it, is of the high-speed variety running at 200 to 250 r.p.m. The calculations were made with a slide rule and are but approximate. ROBERT G. MELROSE.

Detroit, Mich.

Winds Up Discussion on Heat-Work Conversion Law

The letters published in reply to my communication of March 25, are no doubt somewhat of a disappointment to readers of *Power* not directly interested in heat-engine development. In view of the general acceptance of the conversion theory for upward of half a century, they must naturally have expected smashing answers to the flat-footed challenge at the end of my letter, thus disposing of the whole matter without further ado. Reduced to so many words, it would read: "No foundation in actual fact (in a heat-engine) for heat-work conversion theory." Under the circumstances it presumably is not unreasonable to assume that no *real proofs* are available.

Of the several contributors, Professor Emswiler alone has dealt directly with the defined issue. By taking particular pains to restate the proposition in his own words and thus define the characteristic of the "phantom curve," he has made it clear that to him this curve represents a constant (50 B.t.u.) heat-content line above the adiabatic *JL*. Answering him directly, this initial development is simply the necessary incorporation of a clearly pertinent area-segregating line in the otherwise conventional diagram to make it conform correctly to the *presumed* facts. The demonstration proves that the conversion concept will not stand up under analysis.



Reproduction of Mr. Williams' original diagram

Professor Emswiler states that if the 50 B.t.u. of "unconverted" heat are to maintain the increment of pressure between curves *JL* and *IC*, they must have "assistance" which can come only from the so-called "converted heat." However, he neglected to go into details as to *how* the latter can physically function to such end. In the first place (as demonstrated further on), if the supposed conversion actually does take place, then *no such help* is required. If Professor Emswiler will first draw in the isothermal from point *L* and then check up the four quotas of heat involved at successive stages of the stroke, he will find that each minute fraction of each quota is fully engaged, somewhere in the cylinder (while there), in maintaining its own particular increment of pressure, and therefore wholly unable to render "assistance" of any sort whatsoever to the associated heat. The "unconverted" portion must surely have maintained "50 heat units' worth" of pressure throughout the stroke, as well as at the end, where it *admittedly* maintains the increment *LC*.

As previously stated, each of the two areas in question represents the *sum* of the work credited to the portion of heat that functioned to create it. Thus, at any stage of the expansion stroke the pressure increment upon the diagram between the adiabatic *JL* and the "phantom curve" *IC* represents the *sum* of the pressure maintained by the "unconverted" 50 B.t.u. during the stroke, while that between the "phantom curve" and the adiabatic *HC*, represents the *sum* of the pressure maintained by the diminishing 50 B.t.u. portion which constitutes the so-called "converted" heat.

A mere inspection of the figure should be sufficient. If the stroke be reversed and the 50 B.t.u. (of "created" heat) be allowed to accumulate naturally in the confined volume, the pressure will vary along the adiabatic from *C* to *H*. Again, if it is not allowed to accumulate in the gas, then the pressure will vary along the "phantom curve" from *C* to *I*. The difference in work done (shaded area) must therefore be due to the actual physical presence of the "created" heat. On the other hand, in its capacity as potential "converted" heat in the expansion stroke, this 50 B.t.u. can obviously account for *no more* useful work. It is clear that Question 2 still remains unanswered.

The real answer to this question is that the curve *IC* is *not* a constant (50 B.t.u.) heat-content line above the adiabatic *JL*, but is actually a variable which increases from 50 B.t.u. at *I*, to 100 B.t.u. at the point *C*. It is, as Professor Emswiler intimates, a physical impossibility for 50 B.t.u. to maintain unaided (during the expansion) the increment of pressure indicated on the diagram between the two curves *JL* and *IC*. Nevertheless, as clearly proved by the diagram itself, if heat be physically converted and actually disappear from the working volume as claimed, the "unconverted" 50 B.t.u. must therefore of necessity accomplish the impossible. Thus, on its face, the conversion concept is clearly an absurdity.

By courtesy of *Power*, the "phantom curve" is now a matter of engineering record. When this issue has finally been followed through to a definite conclusion, as eventually it must be, a reversion to the so-called "material theory" of Carnot's time will be inevitable. With the theoretical structure again established on a sound basis and the designer thus furnished with effective "tools" (correct formulas), the profession shall then come into its own, for the comparatively minor gains of today will promptly give place to relatively enormous increases in power output per pound of fuel. While various illustrations that bear out the writer's conversion fallacy contention (including a well-authenticated practical physical refutation) are now in hand, the limited space available will not allow of their presentation.

New York City. WILLIAM R. WILLIAMS.

[The debate between Mr. Williams and his critics has apparently reached a stage that might be described as completely unsatisfactory to both sides. Space limitations make it undesirable to continue the discussion further in these pages, but *Power* will be pleased to forward any private correspondence on the subject to the indicated persons. It is unfortunate that the difficulty of expressing thermodynamic ideas in simple language is such that neither side seems quite clear as to what the other is driving at.—Editor.]

QUESTIONS AND ANSWERS

Conducted by Franklin VanWinkle

What Happens When Safeties Set on Elevator Car

The controlling lever or switch in the car of an electric machine is on the full-speed down position. The safeties "set," or through some other cause the car suddenly stops. What then happens to the machine? W. H.

If the safety sets through the action of the governor, the electric contact, if any, on the governor should open and stop the machine. If there is no electric contact on the governor and none on the safety, then the slack-cable device should stop the machine. If the car stops through any cause other than the setting of the safety, the slack-cable device, if any, should stop the machine.

Occasional Roaring of Small Safety Valve

We have a small high-pressure boiler equipped with a pop safety valve which sometimes makes a loud roaring sound when blowing off. Between the safety valve and boiler is a cross-fitting for delivery of steam to the feed pump and engine. How can the roaring be prevented? R. S. S.

It is irregular to have other steam supplies taken out of the safety-valve connection with the boiler. Probably the roaring complained of results from reverberation of steam pressure in the connections to the pump and engine, in which case the noise of blowing off would be different when the engine is taking steam from when it is stopped. The remedy would be to mount the safety valve on a short independent connection with the boiler and thus obtain normal sound of blowing off.

How Low Power Factor Increases the Cost of Electrical Energy

A 5,000-kw. plant produces a kilowatt-hour on 16 lb. of coal. What is the increase in the cost of energy due to low power factor? L. H. C.

The increased cost of power due to a low power factor depends largely on the resistance of the circuit, and is especially marked where there is a high line loss. The table given shows the cost of a kilowatt-hour delivered to the motors with line losses of 5 per cent and 10 per cent, while the generator resistance loss is assumed at 2 per cent. With a 5 per cent line loss the kilowatt-hours delivered to the motor terminals would require 5 per cent more fuel than 16 lb., making 16.8 lb. With 80 per cent power factor, the losses are 8.9 per cent above the original generator loss, which requires altogether 17.4 lb. of coal per kilowatt-hour Since the resistance losses vary as the square of the current, a current of 10 amperes at 100 per cent power factor is assumed, and the resultant total line currents, and also the squares of the resultant currents, are given in the table. The net power is a constant quantity. It will be noted that at 80 per cent power factor and 10 per cent line loss, 18.7 lb. of coal per kilowatt-hour is required to deliver this at the motor terminal. In actual practice the losses are somewhat greater, as more field current is required in order to carry this low power factor and the generator may in some cases be unable to hold normal voltage.

COST OF POWER AT THE MOTOR TERMINALS, GENERATOR LOSS 2 PER CENT, LINE LOSSES 5 AND 10 PER CENT

	At Generator Terminals	Coal per Kilowatt-Hour at Motor Terminals				
Line Loss Five Per Cent						
Power factor, per cent....	100	100	95	90	85	80
Assumed amperes of line..	10	10	10.52	11.11	11.76	12.5[illegible]
Line current squared.....	100	100	110.67	123.3	137	156.2[illegible]
Losses of gen. and line, per cent.....	2	7	7.7	8.6	9.6	10.9
Losses, switchboard to motor.....	...	5	5.7	6.6	7.6	8.9
Lb. coal per kw.-hr.....	16	16.8	16.9	17.1	17.2	17.4
Line Loss Ten Per Cent						
Losses, gen. and line, per cent.....	2	12	13.2	14.8	16.4	18.8
Losses, switchboard to motor.....	...	10	11.2	12.8	14.4	16.8
Lb. coal per kw.-hr.....	16	17.6	17.8	18	18.2	18.7

Cooling-Water System for Oil Engines

We have a 150-hp. vertical two-stroke-cycle semi-Diesel engine. On account of bad water it is desired to install a closed-pipe cooling-water system whereby rain water will be circulated through coils over which raw water is passed. If the water enters the engine jacket at 80 deg. F. and leaves at 150 deg. F., how much 2-in. pipe will be necessary for the coils? W. M.

An engine of this type will use about 0.55 lb. of fuel per brake-horsepower-hour, the oil having 18,500 B.t.u. per pound, which equals $0.55 \times 18{,}500 = 10{,}175$ B.t.u. per horsepower-hour. Of this, approximately 40 per cent is absorbed by the cooling water, or 4,070 B.t.u. per horsepower-hour or 610,500 B.t.u. for a 150-hp. load.

In determining the amount of coils needed it is not desirable to use larger pipe than necessary, as the heat transfer increases with the water velocity.

The amount of water to be circulated through the engines may be calculated as

$$W = \frac{H}{T_1 - T_2}$$

in which

W = Pounds of water per hour;
H = Heat to be removed = 610,500 B.t.u.;
T_1 = Water discharge temperature = 150 deg. F.;
T_2 = Water inlet temperature = 80 deg. F.

$$W = \frac{610{,}520}{150 - 80} = 8{,}722 \text{ lb. of water} = 140 \text{ cu.ft.}$$

The cross-section area of 1½-in. pipe is 0.0123 sq.ft.. so

the velocity of water through the pipe will be 114 ft. per min. The rate of heat transfer will approximate 100 B.t.u. per hour per deg. temperature difference with water at this velocity.

The mean temperature difference, assuming that there is no cooling of the raw water by evaporation as it flows over the pipe, the initial temperature being 70 deg. and the outlet 90 deg. F., is

$$T_m = \frac{(150-90)-(80-70)}{\log_e \frac{150-90}{80-70}} = \frac{50}{1.74} = 28 \text{ deg.}$$

To transmit 610,500 B.t.u. per hour will require

$$\frac{\text{Heat}}{\text{Deg. temp. diff.} \times \text{coeff. heat transfer}} = \frac{610{,}500}{28 \times 100} = 218 \text{ sq.ft.}$$

Since 1½-in. pipe has an internal surface of approximately 0.55 sq.ft., per ft. length there will be required 400 lin.ft. of pipe. If the coils be 20 ft. long, these will need 20 of such pipes, although it is advisable to provide an excess by using 30 pipes.

The raw water should be passed through the coils and delivered to an overhead tank from which it is allowed to flow to the engines. A pump should pick up the water from a sump and force it through the coils. The pump now used can be piped for this service and a second pump, a centrifugal for example, can be installed to handle the raw water from the cooler sump to the cooling tower if the water is to be re-used.

Since it will be impossible to get much more than a 10-deg. rise in the raw-water temperature, there must be 610,000 ÷ 10 = 61,050 lb. of raw water or 7,425 gal. circulated per hour. You will need a 2-in. pipe to handle this water; the horsepower requirements will approximate 0.75 hp. per 10 ft. of pumping head.

Quality of Steam After Adiabatic Expansion

How is it explained that when a pound of dry saturated steam at the pressure of 110 lb. gage containing 1,190.3 B.t.u. is expanded adiabatically to the pressure of 10 lb. gage, the heat content is only 1,069.6 B.t.u., whereas for 10 lb. gage, or 25 lb. per sq.in. absolute, the steam tables give 1,160.4 B.t.u. per pound?

W. J. D.

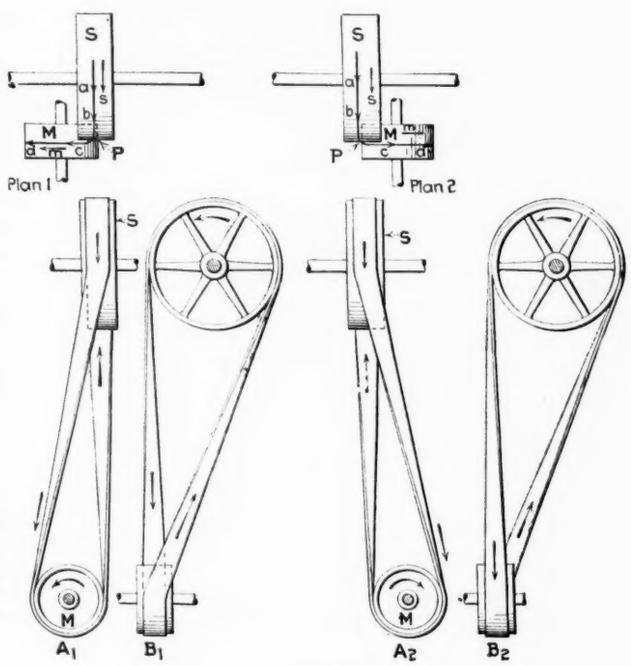
The quantity 1,160.4, quoted from the steam tables, is the total heat of one pound of dry saturated steam at the pressure of 25 lb. absolute. Steam is said to expand adiabatically when no heat is received or deducted except that which disappears as work. During perfect adiabatic expansion so much heat is converted into work that there is not enough heat left at the final pressure for the whole of the original weight of steam to be in dry saturated condition. Each pound (weight) of the steam after expansion will contain the "heat of the liquid" corresponding to the reduced pressure and temperature, but only a fraction of each pound would contain also the latent heat of evaporation corresponding to the reduced pressure. In one pound of steam at the pressure of 25 lb. per sq.in. absolute, the heat of the liquid is 208.4 B.t.u., and as the steam after expansion contains 1,069.6 B.t.u., there remains only 1,069.6 — 208.4 = 861.2 B.t.u. for latent heat. Since the latent heat of one pound of dry saturated steam at the pressure of 25 lb. absolute is 952 B.t.u., it follows that after expansion only $\frac{861.2}{952}$, or about 90.5 per cent of each pound, could be dry saturated steam, and the remainder, or 9.5 per cent, would be water at the same temperature.

Quarter-Turn Belt Drive

What must be the arrangement of pulleys for driving a horizontal shaft from a horizontal motor with a quarter-turn belt? *G. R.*

When driving and receiving pulleys are not in the same plane, then for the belt to remain on the pulleys without the use of a guide pulley, the central plane of each pulley must pass through the point of delivery of the other pulley. According to this rule, where both pulleys are on horizontal shafts, which, in plan, are at right angles to each other, the middle of the falling side of the upper pulley must be vertically above the rising side of the lower pulley.

Referring to Fig. 1 or Fig. 2 and using the same letters of reference in each, suppose *S*, as shown in the plan of each, represents an overhead pulley which is to



Arrangement of quarter turn belt

be driven in the direction indicated by the arrow *s* by a quarter-turn belt from a motor pulley *M* which is below *S* and turns in direction indicated by the arrow *m*.

Then, for the belt to stay on both pulleys, the middle of the face of *S* must be vertically over the middle of the face of *M*, and a plumb-line would touch both pulleys at *P*. It is to be noted that where *s* and *m* indicate the directions of rotation of the pulleys, the belt must pass over the top of the upper pulley and thence to the far side of the lower pulley as indicated in each plan view by arrowheads of a continuous line *abcd*.

The arrangement and direction of the belt for the relative directions of rotation of the pulleys shown in plan 1 are shown in elevations A_1 and B_1, and for plan 2 are shown in elevations A_2 and B_2.

[Correspondents sending us inquiries, should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications, and for the inquiries to receive attention.—Editor.]

Here and There in the Power Plant

Sidelights on things generally used but less generally understood

Fall of Pressure and Superheat in Steam Lines

THERE are many good reasons for insulating a steam line, but the matter of pressure drop is not, as a rule, one of them. Since the condensation of steam is from four to ten times as great in bare pipes as in covered, the conclusion is often drawn that the pressure drop will be much greater if the line is bare. While condensation does increase the pressure loss slightly, the effect is generally too small to be measured. Moreover, as will be shown later, this effect is *indirect*. Condensation causes no *direct* loss of pressure whatever. The common idea that it does arises perhaps from a mental picture of a case that appears to be similar, but is in fact fundamentally different. To get this picture, imagine a length of bare pipe full of dry saturated steam and capped at both ends so that the pipe in reality contitutes a closed tank of steam.

Steam in a Sealed Pipe

If the initial pressure of the steam is 100 lb. gage, its temperature will be 338 deg. and the outer surface of the metal will be but little cooler. The heat loss from steam-heated metal surfaces exposed in still air is approximately 3 B.t.u. per hour per square foot per degree temperature difference between the steam and the air. Then, assuming an air temperature of 70 deg. F., heat will be lost from the outer surface at the rate of 804 B.t.u. per square foot per hour. Suppose that the section under consideration is a 6-in. standard pipe 100 ft. long. The outer surface will be 174 sq.ft and the volume of steam 20 cubic feet.

At the start the weight of steam will be 5.15 lb. The total heat loss per hour from the whole outer surface will be $804 \times 174 = 140{,}000$ B.t.u. at first. It takes 880 B.t.u. to condense one pound of steam at 100 lb. gage. Therefore the steam will start condensing at the rate of $140{,}000 \div 880 = 159$ lb. per hour, or one pound every 23 seconds.

The volume of the condensate will be so small in comparison with that of an equal weight of steam, that it may be neglected. At the end of 23 seconds, then, there will be $5.15 - 1.00 = 4.15$ lb. of saturated steam in a volume of 20 cu.ft., so the weight of each cubic foot of the remaining steam must be $4.15 \div 20 = 0.207$ lb. The corresponding pressure is 76 lb. gage. According to this computation the pressure would fall at the rate of about one pound per second at the start. This rate would continually decrease as the temperature of the pipe was lowered. Since certain refinements have been neglected in making this computation, the result is only a rough approximation, but it does indicate that condensation would produce a very rapid fall of pressure in a bare *closed* pipe. Pipe covering of 80 per cent efficiency would waste only one-fifth as much heat, so the fall of pressure in a covered closed pipe would only be about one-fifth as rapid.

Pipe Connected to Boiler

Now if the pipe, instead of being closed at both ends were closed at one end only, the other being connected to a boiler producing saturated steam at 100 lb. pressure, there would be no measurable fall of pressure. A series of steam gages placed along the pipe would all indicate 100 lb. as closely as an ordinary steam gage can be read.

Yet the condensation would proceed at the same rate as before, one pound each 23 seconds for the bare pipe and one pound in 1 min. 55 sec. for the covered pipe. The pressure would not fall appreciably because new steam from the boiler would continually take the place of that condensed. It would take only a slight drop in pressure from the boiler to the dead end of the pipe to produce all the flow necessary. The rate of flow would be 159 lb. per hour at the boiler end and zero at the other end, an average flow of 80 lb. per hour for the whole length of the pipe. When this is compared with the normal capacity of a pipe of this size, it is seen that no appreciable pressure drop can result from condensation alone.

Condensation Causes Little Pressure Drop

The same statement applies where there is a considerable flow of steam. The condensation increases this flow very slightly and has a correspondingly small effect on the pressure drop.

Although pipe covering has practically no effect on the pressure drop, it has an important effect on the degree of superheat.

While with superheated steam the pipe, particularly if bare, would be noticeably cooler than the steam, this temperature may be used for making a rough computation of the heat loss. Suppose that the pipe under consideration is 6 in., that the steam pressure is 150 lb. gage and the superheat 100 deg. at the start.

The heat loss constant may again be taken as 3 B.t.u. per hour per square foot per degree temperature difference. The initial steam temperature will be 466 deg., giving a temperature difference of, say, 400 deg. Since each running foot of 6-in. pipe has an exterior surface of 1.735 sq.ft., the total loss per hour per running foot will be $3 \times 400 \times 1.735 = 2{,}082$ B.t.u. The drop in temperature depends on the heat taken out of each pound of steam, which in turn depends upon the rate at which steam is flowing through the pipe. If this be 10,000 lb. per hour, the first foot of the pipe would remove from each pound of steam $2{,}082 \div 10{,}000 = 0.2$ B.t.u., equivalent to 0.4 deg. superheat per foot.

If the pipe were made so long that the superheat had about disappeared at the far end, the temperature difference there between the steam and air would be only 300 deg., or three-fourths that at the start. As a result the drop in temperature per running foot would gradually decrease from 0.4 deg. at the start to 0.3 deg. at the finish, the average being 0.35 deg. Using this average for a rough computation, it is clear that for the given conditions a bare pipe would lose all the superheat in 285 ft. The drop in the first hundred feet would be around 38 deg.

Insulation Maintains Superheat

By applying insulation having an efficiency of 80 per cent, the drop could be reduced to one-fifth that for bare pipe. It would then start at 0.08 deg. per foot, so that in one hundred feet of line the fall would be only 8 deg., as against about 38 deg. for the bare line.

It should be noted that this result applies to one set of conditions only. The loss of superheat will increase with the steam temperature. It will decrease with increase in the steam velocity or the efficiency of the covering. If the velocity is doubled, the drop per foot will be reduced by half. The same effect will be produced by increasing the efficiency of the insulation from 80 per cent to 90 or from 70 per cent to 85; that is, by cutting the total heat loss in two. The effect of pipe size is important. For a given weight of steam flowing per hour, the loss of superheat per running foot will be practically proportional to the diameter of the pipe, since doubling the diameter of the pipe doubles its radiating surface and heat loss.

Too Large Mains Wasteful

It is, then, from the economic point of view, a mistake to use an unnecessarily large steam main. The only return from the increased investment in piping, pipe covering, valves and fittings is a reduction in the pressure drop. The steam leaving the boiler must be given additional pressure and superheat equal to the drops in these two items. It is generally easier to boost up the pressure than the superheat.

New and Improved Equipment

Portable pipe-threading machine

Williams Portable Pipe Machine

A new portable pipe threading, cutting-off and reaming machine that fills the gap between the heavy power machine and the ordinary hand stock has been developed recently by the Williams Tool Corporation, Erie, Pa.

The machine is designed especially for being moved readily from place to place and can be taken apart and reassembled in a few minutes. It is arranged for three drives—motor, belt and hand—and by the use of a flexible shaft can be made to operate a hand stock up to and including 8 inch.

The capacity of the machine makes it possible to cut either right- or left-hand threads on pipe ¼- to 2-in. and on bolts ⅜- to 1½-in. inclusive. The cutting-off capacity covers the same sizes of pipe and bolts. The machine will ream the inside and chamfer the outside of pipe from ¼- to 2-in. inclusive. The longest run thread at one chucking is 10½ inches.

A special feature is a high-speed emery wheel which is mounted on the pulley shaft at the rear of machine at a convenient height and driven direct from the motor. The wheel is 6 in. in diameter with ¾-in. face and runs about 1,100 r.p.m. The weight of the machine complete with motor is around 500 pounds.

The Gyro Scrubber

E. M. Bassler, of the Bayley Manufacturing Co., Milwaukee, has brought out a simplified air scrubber, known as the "Gyro Scrubber," which operates on the centrifugal principle and uses water or a special emulsion as its cleaning medium. It is adaptable to industries in which dust, arising from the various processes, is either valuable enough to make recovery profitable, forms a nuisance when released through the stack, or is a source of danger from explosion through a dust-laden atmosphere.

A sectional elevation of the Gyro Scrubber, as designed to handle hot gas or air up to 1,700 deg. F., is shown in Fig. 1. Scrubbers for cold gas are simpler in construction for the bearings and motor need no protection from high temperatures (See Fig. 2). The identical scrubbing principle obtains, however, in either case. Gas enters the scrubber through the central refractory-lined drum at the top and passes through the Gyro wheel. This wheel is conical in shape and has one, two or three concentric rows of pins. The water enters upon the cone at low pressure and is thrown by centrifugal force against and along the first set of pins. This is repeated against each successive ring, the final ring throwing the water with the entrained solid matter against a splash plate or large drum which is hung at some little distance from the wheel. Just as flour or other glutinous substances must be kneaded or stirred to secure mixture with water, so must dust entrained in air be given an impact, in order that each particle may be thoroughly wet and pass off with the water instead of passing through the wheel in a dry or semi-saturated condition.

After passing through the wheel, the air is carried under and around the splash plate and into the bustle pipe which almost completely surrounds the washing chamber, from which pipe it is returned to the room or discharged to atmosphere, with a relative humidity of 60 to 65 per cent. With its entrained solid matter, the water drains down the conical drum into discharge ducts, from which it flows either to settling tanks or to waste. The power requirements, as well as the water consumption, is proportionately small when compared with the results obtained.

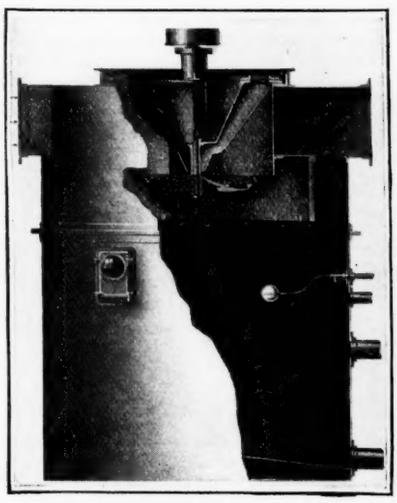


Fig. 2—Scrubber for cold gas

Where it is necessary that the humidity of the air or gas be unchanged or that the temperature remain constant, a special non-evaporating emulsion is used instead of water. There are several installations of this equipment in cement mills, starch plants, etc., where it is claimed that more than 98 per cent of the process dust is removed.

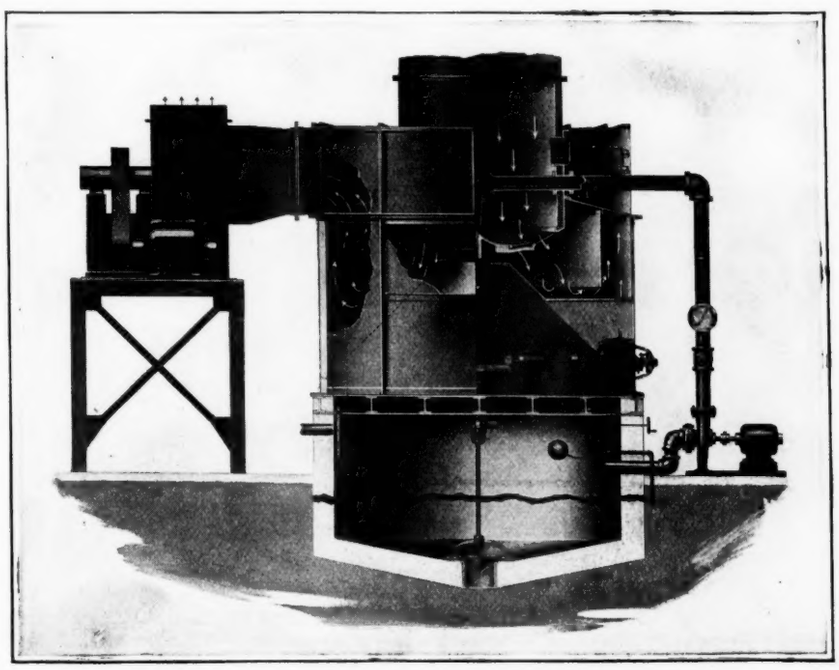


Fig. 1—Sectional elevation of Gyro Scrubber for hot gases

Mettler Surface-Combustion Burner

A burner suitably adapted to burning either gas or oil has been developed by the Lee B. Mettler Co., Los Angeles, Cal. A typical installation of this burner is shown in Fig. 1 and the details of construction in Fig. 2.

The burner consists essentially of two parts, a cast-iron manifold fitted

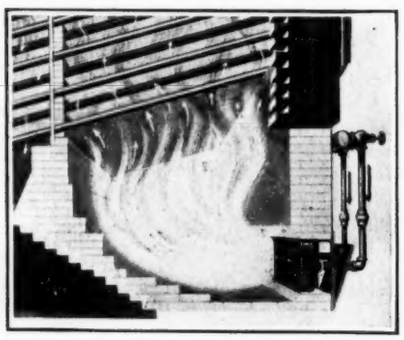


Fig. 1—Burner installation under water-tube boiler

with a series of orifices and a refractory mixing plate. Referring to Fig. 2, which shows the furnace side of the burner, it will be seen that the orifices which emit the gas are arranged on the manifold in groups of four and are set at an angle of 45 deg. This arrangement tends to mix the air and the gas thoroughly while passing through the openings in the plate.

The inner side of the manifold carries a silicon carbide refractory mixing block into which the gas and air are delivered for thorough mixing, the whole being installed as a part of the furnace wall.

When burning gas or oil, all the air necessary for complete combustion passes through the apertures of the manifold and mixing block, the critical point of the mixture taking place as it leaves the surface.

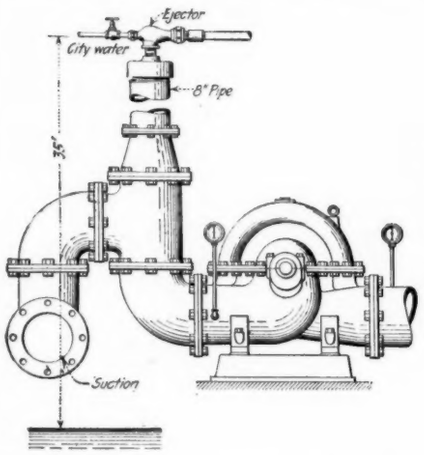
The burners are made in three sizes, eight, sixteen and thirty-two tube. The air and gas mixing tubes are the same on all sizes and are adaptable to practically all sizes of boiler or industrial furnace installations.

Suction Booster for Centrifugal Pumps

The illustration shows a method recently developed by Starkweather & Broadhurst, Inc., Boston, to enable centrifugal pumps to operate with suction lifts materially higher than have heretofore been permissible.

The method embodies a change in the usual suction-piping arrangement and the employment of a high-vacuum ejector connected to a standpipe on the suction line.

Instead of the suction pipe being carried directly to the pump suction, it connects to a sweep tee, located about three or four feet above the suction



Arrangement of suction pipe and ejector connection

opening. To the top of this tee is connected a small standpipe the top of which is carried to at least 34 ft. above the highest water level in the suction well. The bottom of the tee is connected to the pump, preferably with a long-radius elbow. To the top of the standpipe is fitted a water-jet eductor capable of producing a high vacuum, 28 in. mercury or better. When water under pressure is admitted to the eductor, it exhausts the air from the pump-suction piping and standpipe and fills the entire system with water. In this way the vertical head of three or four feet from the top of the tee to the center of the impeller tends to keep the impeller filled with water at all times and eliminates the usual cavitation. The water ejector, if desired, can be replaced by a steam ejector or a vacuum pump, or where convenient the top of the standpipe may be connected to the main condenser provided a reasonably high vacuum is maintained.

It should be noted that this is not intended in any way as a deaërating device, and the standpipe is purposely made small in cross-section to avoid releasing considerable volumes of dissolved air from the water to be handled and removed by the vacuum producer.

New Motoco Dial Thermometer

A new type of dial thermometer for use in the industrial field is a recent development of the Moto Meter Co., Inc., Long Island, N. Y.

The dial of the instrument is of the standard ammeter form with unusually large numerals on white background to facilitate reading at a distance. The instrument is arranged with a flexible bracket to permit mounting in a vertical or horizontal position or at any desired angle between these two positions. The pointer is connected direct to a Bourdon coil making a one-to-one movement and thereby eliminating any intermediate connecting link.

Motoco Industrial Thermometer

The coil of the instrument as well as the flexible connecting tube and bulb are filled with a specially treated alcohol under pressure and which in expanding and contracting causes the coil to wind or unwind, thus imparting movement to the pointer. A feature of the instrument is the exceptionally small bulb, which averages 2 in. in length and ¼ in. in diameter. This permits connecting the instrument to a very small pipe.

The instruments are furnished in eleven dial ranges from minus 40 deg. to 500 deg. Fahrenheit or its equivalent in centigrade. The standard equipment furnished consists of 10 ft. of tubing or 12-in. rigid stem for direct mounting.

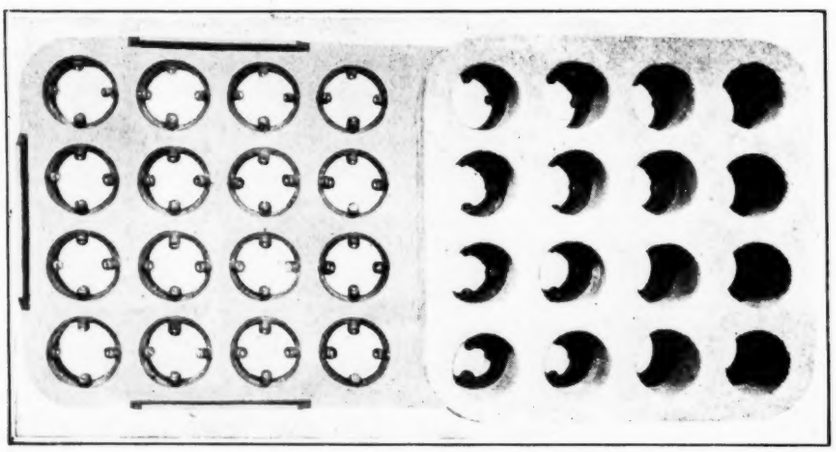


Fig. 2—Furnace side of burner with one section of refractory mixing block removed

The Value of Efficiency in Transforming and Distributing Energy*

BY DR. CHARLES E. LUCKE†

THERE is a real necessity for discovering ways to reduce the cost of power at the point of use as a means of increasing the extent of use, and likewise an equal desirability, if not necessity, for corresponding reductions in the cost of heat. Cheaper heat and cheaper power are national problems, but the discovery of best solutions is an engineering problem, one to be solved only by engineering methods. Engineers know these things, and each of many thousands of engineers is engaged on some one phase of the problem of direct interest to himself or his employer. Unfortunately, there seems to be a lack of complete co-ordination of these efforts, with evidence of working at cross purposes or destructive competition of effort, that might well be reduced in the interests of real substantial progress. A survey of all these activities will reveal a situation more complex than has ever been known and one that is so confusing as to justify any effort to clarify it even partially.

Relative Costs of Service

The very complexity of the power and heat problems of most effective distribution of service at least cost, requires a series of survey studies of great breadth, much more than increased intensity of effort at any one point which may, to the man engaged on it, seem right, but which may not be as worth while as some other.

Of two alternates each equally suitable for the purpose, choice must rest on costs. That one which produces the result at least cost is the better, so that cost of the service prevails when suitability is equal. This is the case when in a steam plant one boiler-room equipment is to be compared with another, or where oil engines, steam or hydraulic turbines are to drive electric generators. There is, however, a third case, and it is the most difficult of all. This is where suitability and costs are both unequal, and when the lesser suitability corresponds with lesser costs.

There is, however, never anything obvious about relative costs of results by alternate or competitive means, especially, as is usually the case, one cost factor is least for one alternative and another least for some different alternative. One of the most common cases of this sort is that in which the process involves an energy loss and for which therefore the efficiency is less than 100 per cent for all alternatives, but where the investment costs are invariably related to efficiencies, with operating costs miscellaneously distributed. This complex case is especially aggravated, assuming that the power source energy available for each system is not the same at the point of generation, and still worse when primary energy costs available for each alternate also vary relatively at different points on an electrical distribution system, any point of which might be a local generating point instead of a substation or consumer point.

Energy Costs

Any cost system that can give a correct picture of competitive values for both heat and power, and applied either to a power or heat problem, to exhibit clearly the relative influence or increasing costs at successive points, of efficiency between points, and of the investment for equipment with disbursement incident to its use, must be based on one common unit for all. The best unit is the B.t.u. and for it the common identical conversion factors are, 2,545 B.t.u. = 1 horsepower-hour, and 3,415 B.t.u. = 1 kilowatt-hour.

The first step in the cost system necessary for judging all sorts of competition in heat and power problems is the setting up of all costs in terms of cost of energy at any point and in any form, and it is most convenient to use costs in terms of cents per million B.t.u.

Considered in its broadest possible aspect, the national problem of heat and power supplies, is to discover the cheapest way of bringing primary energy from its source to the point of use in acceptably suitable form. There are three such forms: (a) Heat, to be utilized as heat; (b) electricity, to be utilized as electricity; (c) power in the form of motion against resistance.

Losses Due to Inefficiency

The common best sources of primary energy are fuels, coal, oil or gas in the earth, and water at an elevation. To get a correct picture of the whole process, the energy costs in cents per million B.t.u. must be evaluated, and periodically checked from source to point of consumption, and at every point between where there is transportation, transmission, or transformation. The more completely this is done, the more clearly it will appear just where costs have accumulated most and where, as a consequence, it is most worth while to exert effort to reduce costs. It will also appear that in this train of successive cost accumulations, other things being equal, the earlier in the train a saving is effected, the greater the ultimate effect at the end of the train, especially when the cost accumulation is the result of inefficiency or actual energy losses, rather than high investments or operating disbursements. It is generally applicable to principle to every such process step that a cost at any one point in the train of transmission and transformation from mine, well or waterfall to point of consumption is the cost of all operations added to the original cost of energy at the starting point.

Each operation or process step adds three cost increments: (a) Increment due to loss of energy: (b) increment due to equipment investment; (c) increment due to operating disbursements.

For a single operation starting at point A and ending at point B the costs are formulated as follows:

Cents per million B.t.u. at B = cost at A in cents per million B.t.u. (A), plus inefficiency increment, cents per million B.t.u. (XA), plus investment increment, cents per million B.t.u. (I), plus operating disbursement increment per million B.t.u. (O), or $B = A + XA + I + O$.

If E = efficiency from A to B, the ratio of output to input energy, then $A + XA = \frac{A}{E}$ and $X = \frac{1 - E}{E}$. Therefore, the inefficiency increment of cost is $\frac{(1 - E)A}{E}$, and the total cost increments for the process are

$$B - A = \frac{(1 - E)}{E} A + I + O$$

This leads to two expressions for the cost per million B.t.u. at the end, in terms of the cost at the beginning, the efficiency of the process and the expenses for investment and operation. These are:

$$B = \frac{A}{E} + I + O$$

$$= A + \frac{(I - E)}{E} A + I + O$$

With this formulation it now becomes possible to establish a measure of *Commercial Efficiency*, E_c, for the process with an algebraic relation to its energy efficiency E. Defining commercial efficiency as the ratio of cost of input energy to cost of output energy, each in cents per million B.t.u. then,

$$E_c = \frac{A}{\frac{A}{E} + I + O} = \frac{AE}{A + E(I + O)} = \frac{E}{1 + E\frac{(I + O)}{A}}$$

Interpreting this expression, the commercial efficiency is equal to the process efficiency, divided by 1 plus the product of process efficiency and the ratio of process expenses to original cost. As the denominator is always greater than unity, the commercial efficiency will always be less than the process efficiency. A numerical example will make these relations more clear. Assume energy of fuel costing 32 cents per million B.t.u. to be transformed to energy of steam available for a turbine, with an over-all process efficiency of 60 per cent and requiring an investment that adds 30 cents per million B.t.u. output, with

*Extract of paper read before Metropolitan Section, American Society of Mechanical Engineers, May 22, 1924, New York City.

†Professor Mechanical Engineering, Columbia University.

operating disbursement adding 25 cents more. Then the inefficiency increment of cost will be

$$\frac{(1-E)A}{E} = \frac{(1.0-.6)}{.6} \times 32 = 21.33 \text{ cents}$$

$$B = A + \frac{(1-E)}{E}A + I + O = 32 + 21.33 + 30 + 25 = 108.33$$

$$B = \frac{A}{E} + I + O = \frac{32}{6} + 30 + 25 = 53.33 + 30 + 25 = 108.33$$

$$E_c = \frac{A}{B} = \frac{32}{108.33} = 29.5 \text{ per cent.}$$

$$E_c = \frac{E}{1 + E\,\frac{(I+O)}{A}} = \frac{.6}{1 + .6\,\frac{(55)}{32}} = 29.5 \text{ per cent}$$

For this case an energy efficiency of 60 per cent yields a commercial efficiency of only 29½ per cent.

This method of judging processes is applicable to a series of processes constituting a system of transforming or of transmitting energy in any form. It is of special value in appraising alternates for single processes or systems where efficiencies of processes may vary considerably with equipment investment and operating disbursement expenses. It shows directly the value of efficiency in terms of all prime variables through the approach to equality of commercial efficiency and process efficiency.

Transportation and Distribution

Considering the fact that electrical energy made from fuel is sold at retail at prices more or less than the round number of 10c. per kw.-hr. retail to small consumers, and 2c. wholesale to large ones, there is evident a very large cost accumulation in the whole series of processes of transportation and transformation from point of production to consumer. As 10c. per kw.-hr. is identically equivalent to 2,498c. per million B.t.u., the small consumer pays from 200 to 500 times as much for energy in the form of electricity at the point of consumption as it cost in the form of coal at coal-production points, and the larger consumer about one-fifth as much, or 40 to 100 times the original value. The difference between wholesale and retail is a measure of the great cost of retail business, the largest single cost accumulation of the system. Even these wholesale cost accumulations are large, corresponding as they do to between 1 and 2½ per cent commercial efficiency, and focus attention on the analysis of all the separate items of accumulation, as a necessary first step in any orderly survey of means of improvement.

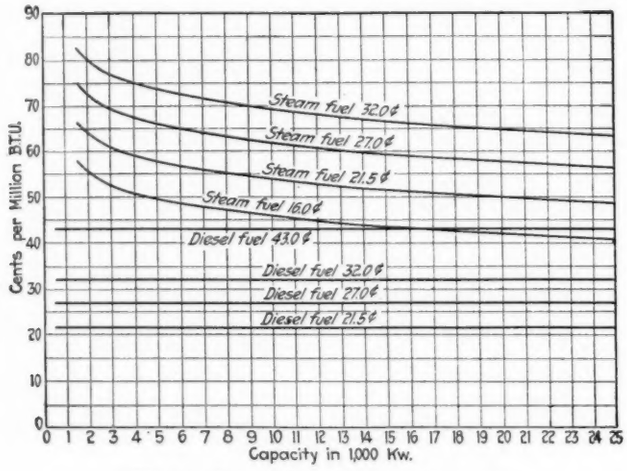


Fig. 1—Costs of working fluid energy

Before any prime mover may begin the process of transforming energy in one of its primary forms into work, there must first be a suitable working fluid carrying the energy in a form best adapted for the prime mover to work as a transformer.

When the case is that of water power, preparation of the working fluid involves the building of all the water-collection, storage, control and conduit systems, including draft tube and tail-water disposal, for bringing water to the turbine under the maximum available head and getting it away. The cost of preparation of working fluid in this case is the fixed charges on this site development, applied to such part of the capacity as represents the average for a year and expressed in cents per million B.t.u.

When the case is that of steam power, preparation of the working fluid involves the making of superheated steam and its delivery to the turbine. There are three items of cost increments making up this total: First, that due to energy losses; second, that of fixed charges on the investment for necessary equipment; and third, the disbursements incident to operation and maintenance of equipment.

Finally, for oil engines there is no cost for preparation of working fluid, because such engines take oil as delivered, and atmospheric air without any preparation, and while the working fluid is actually hot gas, it is not possible to separate the costs of the two functions of converting oil and air into hot gases from that of transforming heat of hot gases into work.

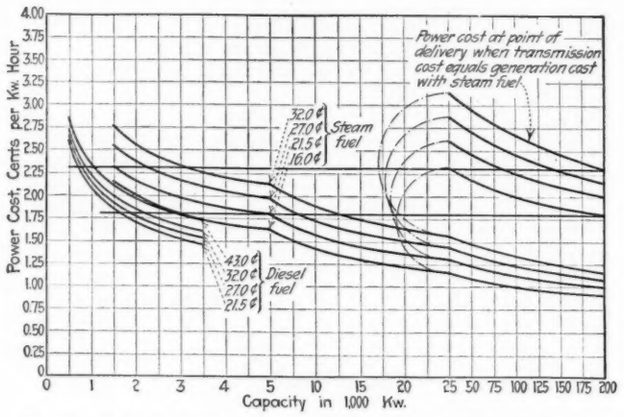


Fig. 2—Total generating costs of steam and Diesel plants

Comparison of Prime Movers

To make the comparison most useful, plant capacity is made a prime variable, and several capacities, 1,500 kw. to 25,000 kw., are estimated for steam turbines, and for Diesel oil engines from 500 kw. to 3,500 kw. are plotted in Fig. 1. This brings out the effect of size on costs in the range where it has most effect, and also the corresponding effect of varying efficiencies which vary less in sizes beyond those used, in the case of steam, while oil-engine efficiencies remain constant. In all cases it is assumed that the load is the same, so that the average efficiencies are less than best by an amount calculated from the average unit load and the number of units in service, with always one main generating unit as a spare. The other details of the plant equipment must be omitted for lack of space, but it is believed that the figures are fairly representative.

Considering the prime mover as an energy transformer, the cost of transformation can be determined in the same way as used for finding the cost of energy made available for the transformation, with the increments of cost due to inefficiency, to investment and to operating disbursements.

Turning to steam turbines and Diesel engines, the figures show that, size for size, the cost of energy for the latter is lower than for the former, and what is especially characteristic, the Diesel engine low costs carry down into much smaller sizes. This difference in the smaller sizes would be more apparent if steam-turbine plants had been estimated for sizes below the

present minimum of 1,500 kw. This has not been done because the result is so apparent, the efficiency of the steam turbine plant falling off in this range so much, and operating disbursements rising with the hand firing of boilers that would be necessary, while Diesel cost increments would increase but little in comparison.

Fuel Costs with Diesels

In the Diesel figures the striking thing is the insignificance of the fuel or inefficiency increment in comparison with those of investment and operating disbursements, as a result of higher efficiency and lower cost of working fluid. This indicates a corresponding justification for the efforts now under way to reduce first costs of Diesel engines without adding to operating disbursements by unreliable designs, and also indicates the real importance of the features of some of the newer American designs. The labor element is, however, the real controlling item of operating disbursements here, not so much because it has to be large, but because the idea of the automatic or semi-automatic plant that has been developed for hydro, and is being studied for steam, is as yet rather a novelty for Diesel engines, where it is well suited. Much is possible here, and great gains in this direction are to be expected. The first steps are being taken in some small installations.

In a general comparison of the steam turbine and the Diesel engine plant, probably the outstanding element is the fact that by reason of the two fuel increment magnitudes, the steam plant is necessarily more affected by fuel price changes than the Diesel oil engine, which can obviously stand much higher prices of fuel without much change in the cost of the energy. This is important for the future, as the general trend of fuel prices is upward, as it always has been.

Cost of Distributed Energy

The summation of all cost accumulations for all the process stages to transform primary energy into electrical, added to the cost of primary energy are plotted in Fig 2., to which are added the values for a 200,000-kw. installation carrying similar loads, and to this, in turn, are added points for twice the value of the generation costs for the big plant, to represent the cost at point of delivery or use far enough away to make electrical transmission costs equal to generation costs in a modern large high-economy station.

Referring to Fig. 2 it is to be noted that each curve is regular in form. For each type of prime mover the curves have a different slope, so that a Diesel power cost line would intersect a steam-turbine power cost line somewhere. A change of fuel price has the effect of displacing either curve bodily upward or downward and so changing the point of intersection This point of intersection is the plant capacity at which both types of prime movers would have equal electric generation costs. It fixes the identical competition for the conditions assumed and divides plant capacity into two zones, one between zero and the plant capacity corresponding to the intersection where Diesel engines give cheaper power, and the other for capacities greater than that at the intersection where steam-turbine power generation is cheaper.

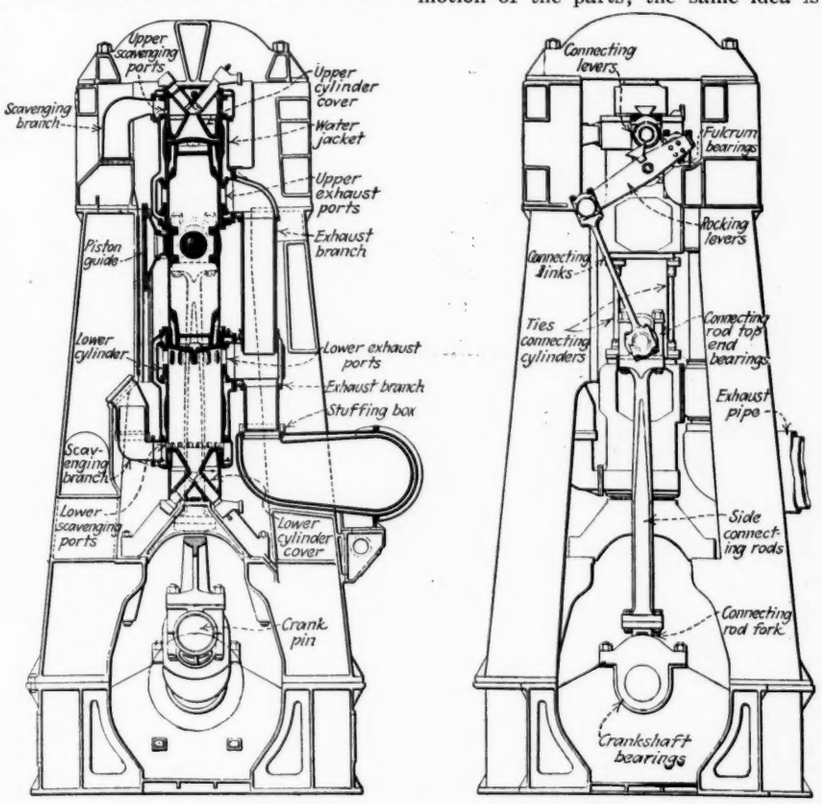
New Double-Acting British Diesel of Unusual Design

Of the many new designs of oil engines introduced during the last few years, the double-acting two-stroke cycle Diesel built by the North British Diesel Engine Works is the most unusual.

The two-stroke cycle has always attracted engineers by reason of its greater power output per unit cylinder volume, but the drawback has been the poor scavenging when the air is introduced through a system of ports. Valve scavenging has been adopted by some, but this calls for a valve gearing and openings in the cylinder head, each of which is objectionable.

The North British firm boldly ventured upon another track and made the cylinder to slide up along the cylinder head; in this the cylinder acts quite like a sleeve valve. At the end of the downward stroke of the top piston the movement of the cylinder past the top cylinder head permits the scavenging-air ports to be uncovered by the head at about the same instant the piston uncovers the exhaust port. The scavenging action is downward through the cylinder, resulting in a complete clearing of the cylinder of burnt gases. On the upward stroke the movement of the cylinder is such that the scavenging ports pass the top head at the time the piston covers the exhaust port. The continued travel of the cylinder, since both top and bottom cylinders are fastened together, causes the scavenging ports of the lower cylinder to pass the lower cylinder head when the lower piston uncovers the exhaust ports.

The mechanism is shown in the illustration, reproduced from *Engineering*, London. The piston is connected to the crank by a forked big-end yoke and side rods. To the ends of the piston pin are swung levers which are pivoted on pins fastened to the upper cylinder head and give the cylinder the necessary reciprocating motion. This head, as is also the case of the lower head, is carried by fixed side columns. The exhaust connection of both top and bottom cylinders are provided with telescopic joints to permit the vertical motion of the parts; the same idea is carried out with respect to the scavenging-air connections.



Cross-section of double-acting diesel

There are three sets of cylinders, 22½-in. diameter by 33-in. piston stroke. At 100 r.p.m. the output is 2,000 brake horsepower. While the engine is too recent to enable intelligent predictions as to its reliability to be made, it does possess features of merit.

A few weeks ago engineers were startled by announcement that 92 per cent efficiency had been reached on a test with a boiler at Hell Gate Station equipped with the new Murray water-cooled furnace, and that a maximum of 528 per cent rating had been attained. We are now able to announce further that in subsequent trials 461 per cent rating was sustained for eleven hours and 603 per cent for a short period. Undoubtedly these figures would have been exceeded had not certain fan and feed-pump limitations interfered.

Stoker Maintenance

By C. E. Harrison

The subject of stoker-maintenance costs is a live one and comes up for discussion wherever engineers meet. That there are many sides to this as to any other subject is not denied, but if one will investigate instances of high costs, it will be found that the matter simmers down in most cases to a question of cost of replacement parts. This is well brought out in the following letter from an engineer to his former assistant, who is now operating his own plant:

Philadelphia, Pa., Dec. 10, 1923.

Dear Friend Will:

I received your letter on the question of stoker maintenance, and as this subject is something of a hobby of mine, I will answer it at length. I am unable to give you any useful data on the cost per ton of coal burned or in terms of either steam or electrical output, for after a review of hundreds of installations, it is my opinion that a general average figure is of no value whatsoever.

In explanation of this, let us look into the various factors affecting maintenance costs. I will assume that it is desired to maintain equipment so it will have its original efficiency at all times. We therefore have the following factors to consider:

a. Original design;
b. Method of operation;
c. Rate of fuel burning;
d. Grade of fuel burned;
e. Total cost of replacement parts.

Taking up these factors in detail, one can say with respect to item *a* that the question of design with respect to maintenance costs should receive attention at the time of purchase, consideration being given to such factors as simplicity of mechanical feeding and operating parts, minimum number of different parts, ease of replacement, particularly of those parts exposed to direct action of the fire, ratio of weight of exposed section of parts to total weight, cooling effect of the combustion air and means for keeping the clinker formation moving downward to be discharged with the ash.

I would ask that you do not skip over the above points lightly—read them over again and see if you do not recognize some of the factors that affect your maintenance costs. But as this letter deals with stokers as installed, we will proceed with consideration of those of the above factors over which you can exercise some control.

Next let us consider item *b*. Is your operation all that it should be? Is the combustible in your ash at a minimum for your conditions? Is your flue-gas analysis up to standard? When does your maximum maintenance occur, during the day or night shifts? Do you really know conditions during the after-midnight hours? Look into this phase of the situation yourself.

The rate of fuel burning, item *c*, determines the furnace temperature which in turn affects the clinker formation and the life of parts exposed to this temperature. The mechanical operating parts are required to operate at a higher rate with increased rates of fuel burning, and increased maintenance must be expected under these conditions. This is so apparent and in agreement with natural laws that no further exposition is necessary.

Coming to item *d*, big-ash coals mean a greater load on the operating mechanism in feeding the same amount of combustible; the load on the ash discharge system is increased and the loss by erosion is also increased. Extremely low-ash coals do not provide sufficient inert matter to protect the furnace parts from the intense heat of the fire.

High-sulphur coals materially increase loss due to corrosion in hoppers and similar parts and usually cause large clinker formation at high ratings.

I find a pronounced tendency to consider purchase price of parts to be the only element of parts cost necessary to consider when calculating total maintenance costs. Nothing could be further from being true. As a matter of fact, in some cases that have been investigated, the purchase price represents only 25 per cent of the total cost of the parts, which we have listed as item *d*.

Do you remember my visit when I remarked about your chipping and fitting on locally made parts and you excused this fact by saying, "Well, we have to keep our repair gang busy in something so they will be able to do a real job of work during an emergency?" This added labor will account for a great deal of the invisible cost.

We didn't discuss the matter in detail at that time, so let us now consider just what constitutes total cost per piece.

Keep in mind that parts purchased from the manufacturer of your stoker are made by the same process, the same organization and from the same patterns as were your original parts.

The elements of cost per genuine part follow:

Material cost:

1. Purchase price of material per piece.
2. Transportation.
3. Receiving. } Purchased-ma-
4. Stock Keeping. } terial burden

Installation cost:

1. Installation labor.
2. Labor burden.
3. Lost productive boiler hours.

Operating cost:

1. Effect of part on furnace efficiency.
2. Life of part in service.

You will note that cost is expressed in terms of "per piece." This is the only basis on which comparison can be made, for you will readily see that a part will not necessarily give an increased life with an increased weight, and I know of many cases where locally made parts run from 25 to 35 per cent over normal weight. This usually means a lot of chipping to make the part fit, and as a net result the real cost "per piece" is vastly increased.

Let us assume that you purchase the actual casting for, say, 10 or even 20 per cent less than the stoker-manufacturer price and that you save an additional 5 per cent on transportation, or a total difference of 25 per cent.

Your receiving cost should remain the same. Stock-keeping cost will be vastly increased, for you will have to maintain a much larger and varied stock to overcome the slowness in delivery from the local foundry. You will also have an appreciable loss due to obsolescence, for the bringing out of new design parts will find you with a stock of old parts on hand. Someone will have to devote a great deal of time to relations with the local foundry-inspecting parts, arranging for slight modification to patterns, running down troubles, repairs to patterns, urging delivery and a multitude of small troubles that always go with manufacture.

Let us put an average value on the above as patterns and repairs 12 per cent and increased stock keeping costs 14 per cent, or a total of 26 per cent. This wipes out your saving already. But there is more to come.

Installation labor is vastly increased, for one cannot argue that parts made from an infrequently used wooden pattern and hand molding can approach in accuracy those made from metal patterns and machine building. Careful check has shown me that the installation labor cost is increased 15 per cent, which, together with the usual labor burden of 100 per cent, makes an added charge of 30 per cent.

I will not put a value on the loss in productive boiler hours due to the fact that this value can be computed only when all the facts are known. I will let you fix a mental value, for I have enough "per cents" without using this factor.

While we all can appreciate the engineer of an inventive turn of mind who likes to change this and alter that and has a ream of figures to prove an increased efficiency, the fact remains that the test efficiency obtained at the time of acceptance usually remains as the mark to shoot at.

The life of the part in service is a much neglected factor; data on this subject are rare. Many engineers can tell you from their records how many tubes were put in No. 4 boiler, others how many bottom-row tubes, and a few how many of No. 7 bottom row, but I have yet to find the man that can tell you how many No. 5 center tuyeres were used in a given boiler. Why is this? The amount involved is sufficient and the stoker can be charted in the same way as is a boiler, and until you have such data I say you are not in a position to argue on comparative life of parts.

I know you like to fuss around with changes, making patterns, machining parts and such tricks, and of course you believe that you are saving your company some money, but don't think that you can get away from "Old Man Overhead" and his alias "Burden." Your job is to run your plant the very best way you know how, and the other fellow's job is to make the best parts he knows how, so I say "Shoemaker, stick to your last." Your Friend,

Steve.

"The best way to understand a super-power system," says General Tripp, "is to regard it as a great reservoir of electric power. Into this reservoir flows power from every available source — steam plants, water-power plants and every other economical source — and from it is drawn power for every possible purpose."

Canadian Hydro-Electric Development

Provision for further hydro-electric development in the Province of Ontario has been included in the legislative estimates. Of total of $2,550,000, $1,700,000 is for extra units at the Ontario Hydro-Electric Power Commission's Nipogon plant at Cameron Falls, Thunder Bay development, and $250,000 for two transformer stations to increase the capacity at Fort William. The remainder is to extend the steel tower• transmission lines from Port Arthur to Fort William, according to *Commerce Reports*.

Government in Need of an Electrical Draftsman

The United States Civil Service announces a non-assembled examination for an electrical draftsman, grade A, to fill a vacancy at the Naval Observatory, Washington, D. C. Applicants must have had training and experience in the design and preparation of drawings for interior and outdoor lighting, communication and signal systems, underground and overhead distribution and transmission systems, power plant and the arrangement of substation equipment. Entrance salary, $2,400, with advancement up to $3,000. Receipt of applications closes July 8.

Option on $50,000,000 Project on Susquehanna River

According to press reports, plans for a large hydro-electric development which may cost as much as $50,000,000 along the Susquehanna River were revealed in Philadelphia recently, when it was learned that the Philadelphia Electric Co., through its bankers, had acquired from Bertron, Griscom & Co., New York bankers, an option on water-power rights at Conowingo, Maryland. Details of the option and of the proposed development were not made public, but the fact that the option has been granted was confirmed by the bankers here.

The Philadelphia Electric Co. plans, when it exercises the option, to organize a separate company under the Maryland laws to operate the properties.

The new properties will supply supplemental and surplus power to the Philadelphia Electric Co. for its own uses at a smaller cost than steam power plants.

The Philadelphia Electric Co. does the entire central station electric light and power business of the City and County of Philadelphia. Including its subsidiaries, the company last year supplied a total of 241,386 customers and had gross revenues of $23,807,746.

St. Louis Has New Smoke Ordinance

An ordinance creating and establishing a section of smoke regulation in the Department of Public Safety which provides for officers and employees, specifies their duties and salaries, with penalties for violation and repealing sections 2199 to 2205 has recently been enacted. It provides for the qualifications of city smoke inspectors as follows:

"The smoke inspectors shall be licensed stationary or locomotive engineers or men having not less than four years' experience in the practice of smoke observation, regulation and prevention, or three years' experience as smoke inspectors. They shall have a knowledge of the principal types of boilers and furnaces in use in the City of St. Louis, the proper methods of stoking or firing them and of the proper grades of fuel for use in each of such types of boilers and furnaces. The smoke inspectors, before appointment, shall be subject to examination before the Efficiency Board to determine their qualifications."

Muscle Shoals Unfinished Business for December 3

Despite the unanimous-consent agreement reached in the Senate at the request of Senator Underwood, to make Muscle Shoals legislation the unfinished business before the Senate Dec. 3, advocates of the Ford offer kept this subject before Congress almost until the last hour prior to adjournment June 7. Senator Heflin, one of the supporters of the Ford offer, spoke each day on the subject, charging that the Republicans had failed to give farmers relief they otherwise would have had if the Muscle Shoals project had been awarded to Henry Ford. In the House, Representative Almon, of Alabama, in whose district Muscle Shoals is located, invited all members to make a trip to the plants during adjournment and get first-hand information.

Under the unanimous-consent agreement in the Senate, Muscle Shoals bills will be taken up as the unfinished business on Dec. 3, which will be the third day of the winter session of Congress, and will remain before that body until disposed of. The procedure under such agreements is that the Senate recess each evening instead of adjourning from day to day, making it possible thereby to renew the same subject promptly upon convening at noon instead of devoting the first two hours of the day to general legislation, which would be the order if an adjournment was taken each evening. When the subject is reached Dec. 3, the bill before the Senate will be the Norris bill as amended and reported by the Committee on Agriculture and Forestry. This provides for a modified form of government control and operation. The strategy of the Ford advocates will be an effort to substitute the McKenzie bill, accepting the Ford bid, which was passed by the House, for the Norris bill.

California Still Troubled by Drought

A hearing was ordered by the California Railroad Commission to be held in Los Angeles on Friday, June 13, to consider the question of operation of electric utilities during the emergency that still persists because of the prolonged drought. All power companies in southern California have been asked to send representatives. The question whether there will be an actual shortage of power is still somewhat doubtful, although present indications are that some shortage can hardly be avoided.

Unless fall rains are later and lighter than usual, the amount of this shortage will not, however, be large for the remainder of the year. The purpose of the commission's investigation was to enable it to require the most efficient distribution of the power available and to insure that any curtailment that may be necessary shall be spread as equitably as possible.

Increased steam generation with consequent higher power costs, brought about by the drought in California, has caused the Edison company to apply to the commission for authority to file and make effective from July 1, 1924, to March 31, 1925, new rate schedules providing for emergency increases over present rates to produce approximately $3,000,000 more revenue. The deficiency in the water supply at present available to the company's hydro-electric plants is the greatest of which any accurate record exists, and the company estimates that its production expenses will be approximately $5,568,000 greater than for an average year.

A 20,000-kw. steam plant is being rushed to completion, and this, together with all existing steam capacity and purchased power from other utilities and private industrial plants, will be utilized to try to avert a power shortage during the late summer and early fall. The company sets forth also that the deficiency in the contingency reserve at the end of the year 1924 will be approximately $4,045,000, which deficiency will leave applicant far short of a fair return for the year 1924, and is too great, it is alleged, to be overcome by possible credits to contingency reserve in the years immediately following 1924.

World Power Conference Delegates and Friends Leave June 19 for London

Many Engineers with Their Wives and Families Sailing on the "Sythia"

MANY of the delegates, engineers, wives and friends who are going to attend the World Power Conference in London, June 30-July 12, will sail on the steamer "Sythia," which leaves New York City on June 19 and Boston, June 20. Among the people attending the conference are:

H. M. Addinsell and Mrs. Addinsell; C. G. Adsit; John Anderson and Mrs. Anderson; W. G. Atwood; Wm. H. Baker; H. H. Barnes, Jr.; J. T. Barron; H. A. Bash; R. C. Beadle; S. Bekku; W. H. Blood, Jr., Mrs. Blood and Miss Blood; Willis H. Booth; H. Bornstein; O. W. Boston and Mrs. Boston; Harold V. Bozell; Alexander Bradley; R. E. Breed; Jos. H. Brewer; W. D. Brookings; H. W. Brooks and Mrs. Brooks; Wylie Brown; Geoffrey C. Brown; Robert G. Brown and Mrs. Brown; N. A. Carle; J. B. Challies and Mrs. Challies; Ralph S. Child and Charles M. Seymour; J. W. Chrisfield and Mrs. Christfield; J. S. Clark and Mrs. Clark; C. W. E. Clarke and Mrs. Clarke; R. I. Clegg; H. E. Clifford, Mrs. Clifford and Miss Clifford; F. R. Coates; W. N. Cole; Jas. V. V. Colwell and Mrs. Colwell; Stafford X. Comber and Mrs. Comber; Lawrence Connelly; C. L. Cory; H. T. Cory; Albert S. Crane; Eugene C. Crittendon; Albert B. Cudebec; F. H. Daniels and Mrs. Daniels; G. M. Davidson, Mrs. Davidson, Howard Davidson, Robt. L. Davidson, and the Misses Frost; George S. Davison; W. J. Delles; W. Elsdon Dew and Mrs. Dew; H. H. Dewey; W. A. Doble and Mrs. Doble; Alfred E. Douglass; Frank O. Dufour; Gano Dunn; W. H. Easton; Harrison P. Eddy; Louis H. Egan, Mrs. Egan and son; W. C. L. Eglin; L. L. Elden; Van Horn Ely; W. L. R. Emmet; Walter G. Farr; Harrison R. Fehr; Samuel Ferguson; Robert H. Fernald and Mrs. Fernald; A. C. Fieldner; Stanley G. Flagg, Jr.; John R. Freeman, Mrs. Freeman and Miss Freeman; Roger M. Freeman and Mrs. Freeman; F. E. Frothingham; George W. Fuller; J. W. Fuller and Mrs. Fuller; L. Fussell and Mrs. Fussell; Gordon Gale; A. J. German; F. B. Gilbreth and Mrs. Gilbreth; Miss Kate Gleason; C. A. Greenidge and Mrs. Greenidge; A. Monro Grier; B. C. Gupta; Arthur T. Hadley; Wm. T. Hamm and Mrs. Hamm; Paul Hansen; H. W. Hardinge and Mrs. Hardinge; T. Chalkley Hatton; C. B. Hawley; Timothy Healy and Mrs. Healy; F. D. Herbert; E. A. Hitchcock; Arthur C. Hobble; Francis M. Hodgkinson and Mrs. Hodgkinson; Maurice Holland; Albert J. R. Houston; John C. Hoyt and Mrs. Hoyt; John Hunter and Mrs. Hunter; C. R. Huntley, Mrs. Pamphret and Mrs. Hilliard; Charles H. Hurd; James T. Hutchings and Mrs. Hutchings; F. L. Hutchinson and Mrs. Hutchinson; Alfred E. Iddles and Mrs. Iddles; Samuel Insull, Mrs. Insull and Miss Bird; Carl D. Jackson; D. S. Jacobus, Mrs. Jacobus and Miss Jacobus; Edwin Jowett and Mrs. Jowett; O. F. Junggren; Peter Junkersfeld, Mrs. Junkersfeld and the Misses Junkersfeld; Alfred J. Jupp; Charles Kellogg and Mrs. Kellogg; A. E. Kennelly, Mrs. Kennelly and R. G. Kennelly; David J. Kerr; G. Bertram Kershaw; Henry H. Knox; George T. Ladd; M. P. Lawrence; J. H. Lawrence; W. H. Lawrence; John W. Lieb, Mrs. Lieb and A. W. Lieb; A. J. Lindemann; Fred R. Low and Mrs. Low; W. S. Lucy; Charles E. Lucke; C. E. Magnusson; Lewis K. Malvern and Mrs. Malvern; L. C. Marburg and Mrs. Marburg; E. F. MacNichol; Thomas N. McCarter; Ira W. McConnell and Mrs. McConnell; H. F. McCullough; E. P. Mathewson; C. R. D. Meier and Mrs. Meier; T. D. Merkill; O. C. Merrill, Mrs. Merrill, Miss Merrill and Miss Waters; John B. Miller; R. A. Millikane; W. S. Monroe, Mrs. Monroe and Henry Monroe; I. E. Moultrop and Mrs. Moultrop; W. S. Murray; J. T. Newcomb; A. P. Niblack; H. E. Nicol; B. Nikifouroff; James P. Noonan; A. E. Norton; George A. Orrok and Mrs. Orrok; C. P. Osborne, Mrs. Osborne, Miss Osborne and Mrs. L. R. Lee; E. W. O'Brien; Ernest V. Pannell; Gilbert H. Pearsall; Langdon Pearse; A. E. Peat, Mrs. Peat, Miss Peat and A. H. Peat; R. St.L. Peverley; John Platt and Mrs. Platt; J. F. Porter and R. E. Porter; P. A. Porter and Mrs. Porter; W. B. Potter; Jack Cooley Pratt; C. H. Prescott and Mrs. Prescott and family; Henry A. Pulliam; O. M. Rau and Mrs. Rau; W. A. Reese; Arthur L. Rice and Miss Elizabeth B. Rice; Calvin W. Rice and Edward W. Rice; E. W. Rice, Jr.; R. Sanford Riley, Mrs. Riley, Robert S. Riley and Miss Riley; C. S. Robinson; J. W. Roe, Mrs. Roe and Miss Lambertson; Wellington Rupp and Mrs. Rupp; David Rushmore; Charles J. Russell; Walter C. Sanders; Jos. V. Santry; W. L. Saunders and Mrs. Perkins; Albert Sauveur; Harlow D. Savage; A. A. Schmidt and Mrs. Schmidt; J. F. Schoelkopf; Paul A. Schoelkopf; R. F. Schuchardt; Henry F. Scott, Mrs. Scott and the Misses Scott; Robert M. Searles; Clayton Sharp, Mrs. Sharp and the Misses Sharp; G. H. Shaw; F. H. Shepard; Robert Sibley; C. E. Skinner and Miss Skinner; M. S. Sloan, Mrs. Sloan and Miss Sloan; Augustus Smith and family; George Otis Smith and J. C. Smith; H. K. Smith; Henry S. Smith; Victor W. Sparr and Mrs. Sparr; Paul Spencer; Elmer A. Sperry; H. N. Spicer and Mrs. Spicer; R. C. Stiefel; L. B. Stillwell, Mrs. Stillwell and son; H. R. Summerhayes and Mrs. Summerhayes; H. H. Suplee; Gerard Swope; Frederick G. Sykes; Robert W. Tassie; Elihu Thomson and Mrs. Thomson; Calvert Townley; Gustave R. Tuska and Mrs. Tuska; James Tyler; W. K. Vanderpool; Eugene Vinet; Frank C. Wagner, Mrs. Wagner and Miss Wagner; R. H. Wainford; L. W. Wallace; Thomas S. Walsh; S. B. Way and Mrs. Way; Clement Wells and Mrs. Wells; A. B. West; George C. Whipple; A. H. White; William M. White; R. B. Williamson; Charles R. Wood; Roy V. Wright and Mrs. Wright; D. Robert Yarnall and Mrs. Yarnall.

Jordan River Water Power Project

The Rutenberg plant for harnessing the waters of the Jordan River to provide Palestine with light, heat and power is about to become an actuality, according to official announcement. The hydro-electric project is being financed in part by prominent Americans.

Ontario May Use Coal from Nova Scotia

The possibility of coal from Nova Scotia providing a solution of Ontario's fuel problem was given consideration in a conference between the Premier and representatives of Nova Scotian coal interests at the Ontario Parliament Buildings.

The coal that Nova Scotia can supply is largely bituminous and more suitable for manufacturing purposes than domestic use. It was claimed that it could be brought to Ontario and sold in competition with bituminous coal from Pennsylvania, according to press reports.

Copco No. 2 on Klamath River Started

As published in *Power*, June 3, the California Oregon Power Co. has under way the project for development of Copco No. 2 hydro-electric plant on the Klamath River in northern California. Construction has begun, and it is expected to have the plant finished and in operation by April, 1925. It will be practically a duplicate of Copco No. 1 and will contain two vertical hydraulic turbines operating under a head of 166 ft., each driving a 15,000-kva. generator. The development will consist of a power house, small concrete diversion dam and combination tunnel and flow line. The diversion dam will be about 1,000 ft. downstream from the present plant and the new plant in turn about a mile farther down the river from the dam.

The California Railroad Commission has approved a 25-year agreement under which the entire output of the plant will be sold to the Pacific Gas & Electric Co. The contract specifies the delivery of 20,000 kw. with a monthly load factor of 70 per cent. At the same time the commission authorized the company to issue and sell securities. A part of the proceeds from the sale of these securities will be used to finance the new power development, which it is estimated will cost $3,690,000, and to provide $1,534,000 which will be used for necessary extensions and betterments to the system during the year 1924.

Spring Meeting of the American Boiler Manufacturers' Association

Principal Revisions in Boiler Code are Given—Same Officers Elected

THE THIRTY-SIXTH annual convention of the American Boiler Manufacturers Association was held at the Homestead, Hot Springs, Va., June 9, 10 and 11.

President E. R. Fish in his address said that the discussion of the technical details of boiler construction was now taken care of by a larger and more inclusive organization, the field of the A.B.M.A. now lying more especially in the non-technical and commercial lines.

Other organizations such as the League for Industrial Rights, National Metal Trades Association, United States Chamber of Commerce, National Industrial Board and local association of the same character and having similar objects, should be supported by all who are engaged in industrial activities.

One of the most interesting developments at the recent annual meeting of the National Metal Trades Association was the extent to which the health of employees is being looked after by many companies, coupled with group insurance either gratuitous or paid at a low rate.

He dealt at length, and struck the keynote of the meeting, upon the radical tendencies of the times and the efforts that are said to be made to overturn the social and industrial order.

Secretary Hoover's plan for simplification in connection with the "Elimination of Waste in Industry" was mentioned with approval, although it was one to which, unfortunately, the product of the boiler manufacturer does not readily lend itself.

He mentioned the plans of the War Department with respect to preparedness and urged co-operation with the government authorities.

As representative of a relatively small but not unimportant specialized industry, we should do our part both selfishly and unselfishly for our own individual welfare as well as for that of the great and glorious country which we are proud to call our own, by co-operation with those agencies that stand for law and order and the kind of progress for which our governmental institutions fully provide.

Mr. Merle Thorpe, editor of *Nation's Business* spoke upon, "Business is Business," condemning the use of the saying and the attitude of mind that it represented in palliating questionable practices.

President Kenneth K. McLaren, of the Corporation Trust Co., of New York, was to have presented a paper upon "Doing Business in Foreign States," but was unable to attend. The paper, which dealt with the legal complications of doing business across interstate boundaries, was read by Carroll C. Robertson.

Fred R. Marvin, editor of the Searchlight Department of the *New York Commercial*, speaking upon "Radicalism," proved an ardent apologist for and apostle of existing conditions.

Among the reports from various committees was that of E. C. Fisher upon the A.S.M.E. Boiler Code, pointing out as it did the principal respects in which the Code had undergone revision.

"If those who do not wish to order Codes in the larger quantity mentioned will send their order to H. N. Covell, Secy. of the A.B.M.A., he can group the orders and in that way obtain the lowest price for our members.

"The Code has been very much improved in the revision. Quite a number of changes have been made, and in consequence your committee recommend that the members of this association procure and distribute as many copies of the revised Code as possible, so as to educate the public to the standard to which we are working.

"We also recommend that the members of this association who have not already applied to the A.S.M.E. Boiler Code Committee for their registration numbers do so at once. The following are some of the principal changes which have been made from the 1918 Code:

"The specifications for material have been added to some extent, and some changes have been made. It would be advisable for our members in ordering their material, to order to the new Code just as quickly as possible, in order that their stocks may be up to date.

"The elongation requirements for firebox steel has been slightly increased.

"The Revised Code paragraphs will be prefaced by the letter P, to indicate the Power Code, the material specifications being grouped by themselves and prefaced by the letter S; the letter L to preface the paragraphs in the Locomotive Boiler Code; the letter M in the Miniature Boiler Code; and the letter U in the Unfired Pressure Vessel Code. The old paragraphs have been adhered to in the Revised Code in so far as possible.

"P-12 has been revised to make it clear and distinct that cast iron shall not be used for nozzles or flanges attached directly to the boiler for any pressure or temperature.

"Tables P-2 and P-3. These tables cover tubes or nipples for water-tube boilers. There is one table for steel tubes and one table for wrought-iron tubes. In the old Code one table covered both makes of tubes.

"P-23, P-24 and P-25 are new paragraphs in the Boiler Code, which cover thickness of steam piping and feedwater piping and blowoff piping.

"P-184d specifies the minimum distance from the center of rivet hole of circumferential joints to the edges of the plate to be not less than 1¼ times the diameter of the rivet hole.

"P-185. This paragraph has been revised so that plates over ⅝ in. in thickness in horizontal return-tubular boilers, instead of $\frac{5}{16}$ in. shall be planed or milled down to a thickness of not over $\frac{5}{16}$ in. at the circumferential joint in place of ½ in. in the old Code. You will remember this paragraph was discussed at our meeting held in Pittsburgh Feb. 13, 1922, at considerable length, and I believe the change will be welcomed by all.

"P-194. The diameter of the dome on a locomotive or horizontal return-tubular boiler shall not exceed 0.6 the diameter of the shell of the boiler.

"Table P-7 has been revised so as to clear up some confusion as to what constitutes a stay, what constitutes a brace, and what constitutes a staybolt.

"P-248 has been revised so that cutting of plates may be done by machining, punching, shearing, or by means of an electric arc or gas process, provided enough metal is left so that the edges may be finished in accordance with paragraphs P-249, P-253, and P-257.

"P-253 requires that all holes in braces, lugs and sheets shall not be punched in material that exceeds ⅝ in. in thickness.

"P-260 has added a cut, showing more clearly the allowance in figuring manhole reinforcing rings.

"P-276 is an important change. It provides that when two or more safety valves are used on a boiler, the valves shall be made of equal size if possible; and in any event, if not of the same size, the smaller of the two valves shall have a relieving capacity of at least 50 per cent that of the larger valve.

"P-278 requires on fire-tube boilers that the openings for safety valves shall be not less than in Table P-11. Table P-11 is the same as the intermediate lift of Table 15 in the old Code.

"P-308 specifies the maximum size of blowoff opening 2½ in., but the Boiler Code now permits the use of return connections of larger size to which the blowoff may be connected. It requires, however, that the blowoff must be so located on the return that the connection may be completely drained.

"P-323 and P-324. These paragraphs have been clarified by using the terms 'lugs and *hangers*' in the place of the terms 'lugs and *brackets*,' hangers referring to the type of support used when the boilers are to be hung from gallows frames.

"P-331. Stamps on boiler plates may be transferred when necessary, under the supervision and authority of an authorized State, Municipal, or Insurance Inspector. The mill stamps must not be imitated in this transfer.

"P-332. The form of stamping on a boiler has been much simplified. A register number for each boiler manufacturer has been added, while the 'States' number,' and the 'State in which the boiler is to be used' is omitted. Each manufacturer must secure his register number from the A.S.M.E. Boiler Code Committee.

"This Paragraph provides, in cases where boilers cannot be completed and hydraulically tested before shipment, that the proper stamps shall be applied at the shop, and two data sheets signed by the same or different inspectors, covering the portions of the inspections made at the shop and in the field. The data sheets to be sent to the proper destination.

"The Manufacturers Data Report has been revised and changed to better suit all the different interests who have to do with it. It is believed this report

will be found easier to work and will give to the inspectors the data required in a form permitting of quicker calculation."

The usual golf tournaments were played and a banquet at which the purses were awarded was held on Tuesday evening.

The entire list of officers were reelected: President, E. R. Fish; vice-president, E. C. Fisher; secretary and treasurer, H. N. Covell; executive committee, George W. Bach, G. S. Barnum, F. G. Cox, W. C. Comnelly, W. A. Drake, A. R. Goldie, J. F. Johnston, M. F. Moore, A. G. Pratt; E. C. Fisher representing the A.B.M.A. in the A.S.M.E. Code Committee.

Montefiore Electrical Development Prize

A triennial prize of 15,000 francs for the best paper presented on scientific progress and development in any branch of electricity has been established by the George Montefiore Foundation, Liege, Belgium. This prize was instituted by George Montefiore, late President of Honor of the Institut Electrotechnique Montefiore.

The competition for the 1923-25 award is now open, and all works submitted for this prize should be received by the Foundation by April 30, 1925. The amount of the prize for this term is approximately 22,500 francs, which is somewhat greater than the normal amount.

Detailed information may be secured from M. le Secretaire-Archiviste de la Fundation George Montefiore, Association des Ingenieurs Electriciens, rue Saint-Gilles, 31, Liege, Belgium.

S.P.E.E. Has Good Program Outlined

Boulder, Colo., will be the gathering place of the Society for the Promotion of Engineering Education this year, its thirty-second annual meeting being scheduled for June 25-28 at the University of Colorado. Among the papers to be presented are: "The Meaning of the Bachelor of Science Degree in Engineering," by H. S. Evans, dean of the College of Engineering, University of Colorado; "The Student as an Individual," by Carl E. Seashore, dean of the Graduate School of Iowa State University; "Fifteen Years of Experience with a Five-Year Engineering Curriculum," by W. H. Burger and J. F. Hayford, of the North-western University, Evanston, Ill. Addresses will be made by the president of the society, Dean P. F. Walker of the School of Engineering, University of Kansas, whose subject will be "Public Service Aspects of Engineering," and by Frank Aydelotte, president of Swarthmore College, Pennsylvania. Director W. E. Wickenden will report for the board of investigation and co-ordination.

Personal Mention

Charles Herbert Baker has recently become associated with the Sessions Engineering Co., consulting engineers, 208 South La Salle St., Chicago, Ill.

Coming Conventions

American Electrochemical Society. Dr. Colvin G. Fink, Columbia University, New York City. General meeting at Detroit, Mich., Sept. 25-27.

American Institute of Chemical Engineers. Dr. John C. Olsen, Polytechnic Institute of Brooklyn, New York. Summer meeting in Denver, July 16-19.

American Institute of Electrical Engineers. F. L. Hutchinson, 33 West 39th St., New York City. Annual convention, Edgewater Beach, Chicago, Ill.. June 23-27.

American Society of Civil Engineers. J. H. Dunlap, 33 West 39th St., New York City. Convention, Pasadena, Calif., June 18-21.

American Society for Testing Materials. C. L. Warwick, University of Pennsylvania, Philadelphia, Pa. Annual meeting, Chalfonte-Haddon Hall, Atlantic City, N. J., June 23-28.

Association of Iron & Steel Electrical Engineers, John F. Kelly, 1007 Empire Bldg., Pittsburgh, Pa. Annual meeting and exposition at Duquesne Garden, Pittsburgh, Pa., Sept. 15-20.

Association of Municipal Electrical Utilities of Ontario. S. R. A. Clement, 190 University Ave., Toronto, Ont. Meeting at Niagara Falls, June 26-28.

Canadian Association of Stationary Engineers. Gordon C. Keith, 51 Wellington St., West Toronto, Ont. Annual meeting, St. Thomas, Ont., June 24-26.

Fourth International Congress of Refrigerating Engineers. J. Raymond, Weavers' Hall, 22 Basinghall St., London, E.C. 2. Held under the auspices of the International Institute of Refrigeration, at the Ministry of Labour, London, Whitehall, S.W. 1, June 16 to 21.

Management Congress, First International Prague, Czechoslovak, July 21-24.

National Association of Stationary Engineers. Fred W. Raven, 417 South Dearborn St., Chicago, Ill. Annual convention and exhibition at Hotel Pantlind, Grand Rapids, Mich., Sept. 8-13. Annual conventions and exhibitions of the state associations are scheduled as follows: **Ohio Association** at Akron, June 19-21. T. S. Garrett, 2622 East Second St., Dayton, Ohio. **Connecticut Association** at Bridgeport. June 27-28. George F. Klopfer, 30 East Pearl St., New Haven, Conn. **New England States Association** at Cambridge, Mass., July 10-12. Freeman L. Tyler, 32 Briggs St., Taunton, Mass. **Wisconsin Association** at Fond du Lac, July 24-26. Vincent Todd, 25 Fourteenth St., Fond du Lac. **Minnesota Association** at Faribault, Minn., July 31, Aug. 1-2. C. A. Nelson, 800 22nd Ave., N. E. Minneapolis. **Michigan Association** at Grand Rapids, Sept. 8. Wm. H. Yeomans, 209 Plainfield Ave., Grand Rapids.

New England Water-Works Association, Frank T. Gifford, 715 Tremont Temple, Boston, Mass. Annual convention at Powers Hotel, Buffalo, N. Y., Sept. 23-26.

Northwest Electric Light & Power Association. C. H. Gueffroy, Pacific Power & Light Co., Portland, Ore. Convention at Gearhart Hotel, Gearhart, Ore., June 25-27.

Ohio Electric Light Association. D. L. Gaskill, Greenville, Ohio. Annual meeting at Hotel Breakers, Cedar Point, Ohio, July 8-11.

Society for the Promotion of Engineering Education. Charles F. Scott, University of Pittsburgh, Pittsburgh, Pa. Annual meeting, University of Colorado, Boulder, Colo., June 25-28.

World Power Conference. O. C. Merrill, Federal Power Commission, Washington, D. C. British Empire Exhibition, Wembley, London, June 30-July 12.

Carroll F. Merriam, whose comments on engineering matters have appeared in *Power* from time to time, has resigned as instructor at the Worcester Polytechnic Institute to accept a position with the Pennsylvania Water & Power Co., Baltimore, Md.

Dr. Ing. Hugo Junkers, of Dessau, Germany, inventor of the Junkers oil engine, arrived in the United States on June 6.

F. A. Gaby, chief engineer of the Ontario Hydro-Electric Power Commission, and **Henry G. Acres,** until recently chief hydraulic engineer of the commission, have received the degree of doctor of science from the University of Toronto in recognition of their public service.

Herman Lemp, engineer in charge of the internal-combustion engine, engineering department of the General Electric Co., has resigned from that company, with which he had been connected for 42 years, to join the Erie Steam Shovel Co.

Obituary

Donald McDonald, president and general manager of the Louisville Gas & Electric Co., died on June 3 after suffering a stroke of apoplexy while delivering an address before the Electric Club on June 2. Mr. McDonald was born at Winchester, Va., Sept. 5, 1858, but had been connected with important public utility activities in Louisville, during the greater part of his 66 years. His loss will be deeply felt by those who were associated with him.

Business Notes

The Pennsylvania Pump and Compressor Co., Easton, Pa., desires to announce that L. D. Burke, 68 Starr St., New Haven, is its sole representative for the State of Connecticut.

The Trico Fuse Manufacturing Co., Milwaukee, Wis., announces the removal of its New York City office to 154 Nassau St. R. F. Waldo is district manager in charge.

The Chicago Pneumatic Tool Co. announces the opening of a branch office at 210 South Jefferson St., Dallas, Tex. J. O. Bailey will be in charge.

United Stokers Co., Laporte, Ind., has appointed E. H. Bull & Co., Jackson Boulevard, Chicago, Ill., as the company's representative for the Chicago district.

Universal Coal Spreader Co., Chicago, Ill., announces that the Power Auxiliary Co., Penton Bldg., Cleveland, Ohio, will handle the sale of its equipment in the Cleveland district.

Arca Regulators, Inc., is the name of a new firm, incorporated by Kissel, Kinnicutt & Co., 14 Wall St., and Chas. Cory & Sons, Inc., 183 Varick St., New York City, for the manufacture and sale of Arca regulators in this country. The offices of the new firm are in the Grand Central Terminal Bldg., 452 Lexington Ave., New York City.

Trade Catalogs

Fans—American Blower Co., Detroit, Mich. Bulletin No. 1613 describes the "Ventura" disk fans, with tables of dimensions, etc. Bulletin No. 1002 describes the "Sirocco" fans with tables of capacities and dimensions.

Insulation, Boilers—Celite Products Co., Chicago, Ill. Bulletin B-6E describes in detail the method of insulating employed for various types and sizes of boilers, and gives figures on the fuel saving that can be realized by insulation.

Valves—The Edward Valve Manufacturing Co., East Chicago, Ind. Catalog No. 8 devotes 39 pages to non-return stop and check valves, stop valves, blowoff valves, drumhead valves used as feed-line stop and check, atmospheric relief and check valves, special adaptations and valves for the higher pressures from 400 to 900 lb., with tabulations giving the newly accepted American flange standards for pressures from 250 to 900 pounds.

Varnishes and Compounds — The Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. Booklet describing the varnish products put out by this company.

Pumps, Dry Vacuum—Sullivan Machinery Co., Chicago, Ill. Bulletin No. 78-B gives description of classes WA-61 and WG-61 single cylinder, steam and belt-driven dry vacuum pumps.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	June 2, 1924	June 9, 1924
Pool 1	New York	$3.00	$2.85
Smokeless	Columbus	2.40	2.45
Clearfield	Boston	2.35	2.40
Somerset	Boston	2.50	2.50
Kanawha	Columbus		
Hocking	Columbus	1.85	1.85
Pittsburgh No. 8	Cleveland	1.90	1.90
Franklin, Ill.	Chicago	2.50	2.50
Central, Ill.	Chicago	2.25	2.25
Ind. 4th Vein	Chicago	2.50	2.50
West Ky.	Louisville	1.75	1.75
S. E. Ky.	Louisville	1.75	1.75
Big Seam	Birmingham	2.00	2.00

FUEL OIL

New York—June 12, light oil, tank-car lots, 28@34 deg. Baumé, 5½c. per gal., 36@40 deg. 6c. per gal., f.o.b. Bayonne, N. J.

St. Louis — June 3, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.60 per bbl.; 26@28 deg., $1.65 per bbl.; 28@30 deg., $1.70 per bbl.; 32@36 deg., gas oil, 4½c. per gal.; 38@40 deg. 5½c. per gal.

Pittsburgh—June 5, f.o.b. local refinery, 30@34 deg., fuel oil, 5½c. per gal.; 36@40 deg., fuel oil, 5½c. per gal.; 34 deg., neutral, 8½c. per gal.

Dallas—June 6, f.o.b. local refinery, 26@30 deg., $1.30@$1.35 per bbl.

Philadelphia — June 5, 28@30 deg., $2.20½@$2.268 per bbl.; 18@22 deg., $2.10@2.16½; 13@16 deg., $1.78½@$1.848 per bbl.

Boston—May 29, tank-car lots, f.o.b. heavy oil, 12@14 deg. Baumé, 4¾c. per gal., light oil, 28@32 deg., Baumé, 6¾c. per gal.

Cincinnati — June 3, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 4¾c. per gal.; 26@30 deg., 5½c. per gal.; 30@32 deg., 5⅝c. per gal.

New Plant Construction

Ala., East Florence—W. T. Wahl plans for the purchase of a turbine fan, steam-driven, about 12-in. blades.

Alaska, Ptersburg—Hubbell & Waller, Alaska Bldg., Seattle, Wash., engineers, have been authorized to proceed with a hydro-electric project at Crystal Lake, near Petersburg, to cost approximately $115,000.

Ariz., Jerome—The United Verde Copper Co. has commenced work on the remodeling and extension of the power plant at its mining properties, including additional equipment. Robert Tally, general manager.

Calif., Fresno—The People's Ice Corp. has awarded a building contract to Russell Hess, Fresno, for additions to its plant, including an engine room, tank house, and daily cold storage house. Equipment purchases will be made soon. J. R. Erskine, engineer and general manager.

Calif., Grass Valley — The Board of Directors, Nevada Irrigation District, plan for a hydro-electric plant in connection with its proposed Jackson Meadows irrigation project. It is proposed to vote bonds for $6,000,000. Fred H. Tibbetts, Alaska Commercial Bldg., San Francisco, Calif., consulting engineer.

Calif., Long Beach—The Southern California Edison Co., will proceed with its proposed steam plant at Terminal Island, 270 x 270 ft. Plans have been completed by Stone & Webster, Inc., 147 Milk St., Boston, Mass., engineer and contractor. The station will cost $1,250,000.

Calif., Oxnard—The Board of City Trustees has authorized specifications for two horizontal centrifugal pumping units, motor-driven, for the waterworks. Frank B. Pettis, city clerk.

Conn., New Britain—The State Board of Education, Hartford, will take bids about June 25, for a boiler plant and coal pocket at the state normal school. Alfred Kellogg, 89 Franklin St., Boston, Mass., engineer. W. F. Brooks, Gold and Lewis Sts., Hartford, architect.

Fla., Cocoa—The Cocoa Beach Development Co. plans for an electric plant for light and power in connection with a land development for residential service.

Fla., Florida City — The Southwestern Canning Co., Homestead, Fla., is considering a boiler house at its proposed canning plant. The complete work will cost about $30,000.

Fla., Fort Pierce—The St. Lucie Ice Co. plans for a refrigerating plant and storage addition to its ice-manufacturing plant, to cost $27,000. R. Whyte, president.

Fla., Sanford—The City Council will begin the erection of a power house to be used in connection with extensions in the municipal waterworks. A building contract has been awarded to Hall & Harris, Orlando, Fla.

Fla., Sarasota—L. L. Richardson, Sarasota, and associates plan for a refrigerating plant on tract of property near the city, to be known as Richardson.

Fla., Smyrna—The City Council, George J. Ott, city manager, plans for additional equipment at the municipal power plant and will install two generators, about 600 and 800 hp., respectively; two oil-burning engines, direct-connected to generating units; pumps for water cooling service; engine controls; switchboard apparatus, etc.

Fla., St. Petersburg—The Citizens Ice & Cold Storage Co. has arranged a fund of about $500,000, for extensions and improvements in its ice-manufacturing plant and branch plants at Gulfport, Pasadena and Pinellas Park. It is expected to double the present capacity.

Fla., Vero.—The Non-Acid Fertilizer Co. contemplates a boiler house at its proposed fertilizer works, for which work will start soon.

Ga., Byromville—The Lester-Ricks Oil Co. is planning for a return tubular boiler, about 70 hp., and auxiliary equipment.

Ga., Columbus—The Minter System, Inc., manufacturer of brick plant equipment, plans for a Corliss engine, about 80 hp., with auxiliary apparatus.

Ga., Griffin—Y. S. B. Gray & Son, operating a canning plant, are planning for a deep-well pump, 40 hp. boiler, water tank of 2,000 gal. capacity, and other equipment.

Ill., Granite City—The St. Louis Coke & Iron Co., St. Louis, Mo., has authorized plans for an electric power plant at its proposed blast furnace at Granite City, with heavy gas engines as prime movers, using gas from the furnaces. It is proposed to dispose of the output to electric utilities operating in this section. The entire project will involve $2,500,000. W. C. Maguire, president.

Iowa, Bellevue—The Johnson Piano Co. is reported to be planning for a boiler plant in connection with the proposed rebuilding of its factory, recently burned with loss of $200,000.

Iowa, Council Bluffs—The Illinois Central Railroad Co., 135 East Eleventh Pl., Chicago, Ill., is said to be perfecting plans for its new local shops, to include a boiler plant. The entire project will cost $200,000.

Iowa, Shenandoah—The Common Council has authorized plans for a pumping plant at the waterworks, to replace a structure recently burned. Frank H. Sanman, city clerk.

Japan, Tokio—The Department of Railways has announced plans for a hydro-electric development on the Shinano River, about 100 miles from the city, for which a fund of $20,000,000, has been arranged, including transmission system.

Kan., Brookville—The Common Council is said to be planning for centrifugal pumping equipment in connection with a municipal water system. Plans have been prepared by the Ruckel Engineering Co., Interurban Bldg., Hutchinson, Kan., consulting engineer. R. Lynn Martin, city clerk.

Ky., Morganfield—The City Council is asking bids until June 24 for waterworks extensions and equipment, including two high-lift centrifugal pumps, each with capacity of 350 g.p.m.; and one low-lift horizontal centrifugal pump, capacity 1350 g.p.m., with auxiliary apparatus. Gannett, Seelye & Fleming, Randolph Bldg., Memphis, Tenn., engineers.

Mass., Falmouth—The Marine Biological Laboratory, Woods Hole, near Falmouth, is making extensions in the laboratory, to include a new pumping plant. Coolidge & Shattuck, Ames Bldg., Boston, Mass., architects.

Mass., Lynn—The Lynn Gas & Electric Co. has work in progress on additions to its steam plant, to include boiler equipment, 7500 kw. turbo-generator, and auxiliary apparatus.

Mass., Norton—The Board of Trustees, Wheaton College, will proceed with the erection of the steam power house at its institutional building, estimated to cost $80,000, for which a building contract has been awarded to the Edward F. Miner Building Co., 25 Foster St. Cram & Ferguson, 248 Boylston St., Boston, architects.

Mich., Albion—The Michigan Artificial

Ice Products Co., Detroit, has taken title to a tract of land as a site for its new ice-manufacturing and cold storage plant, for which plans are being completed. It is expected to start at once. Estimated cost $85,000.

Mich., Detroit—The City Council has authorized a call for bids for the proposed municipal steam electric generating plant at the foot of Morrell St., estimated to cost $12,000,000, complete. The Public Lighting Commission is in charge.

Mich., Detroit—The Standard Oil Co., 1011 4th St., is said to be planning for pumping equipment at its storage and distributing plant on Scotten Ave., estimated to cost $110,000. A building contract has been let to Bryant & Detwiler, Dime Bank Bldg.

Mich., Iron Mountain—The Ford Motor Co., Highland Park, Detroit, will proceed with a hydro-electric generating plant on the Menominee River, with initial capacity of 10,000 hp., for service at its local chemical factory, lumber mills, etc. Construction of power dam is in progress.

Minn., Albany—The Common Council will soon take bids for one 300 g.p.m. electric-operated pump, for waterworks service. R. E. Borrowman, Weber Bldg., St. Cloud, Minn., engineer.

Minn., Le Sueur—The Common Council contemplates centrifugal pumping equipment for extensions in the municipal waterworks. It is expected to ask bids during the summer. Ralph W. Richardson, Zenith Bldg., St. Paul, Minn., engineer.

Minn., Madison—T. M. Hoff, city clerk, will take bids until June 27, for one horizontal return tubular boiler, with capacity of 150 hp.; also, hopper feed hand stokers. The equipment will be used at the municipal lighting plant.

Minn., Red Wing—The City Council has awarded a general contract to C. Walter Johnson, Red Wing, for a house for pumping equipment at the waterworks.

Minn., St. Paul—The Board of Trustees, Macalester College, will take bids at once for the steam power plant, at the institution, estimated to cost about $50,000 with equipment. William M. Ingeman, Endicott Bldg., architect.

Mo., Harrisonville—The Common Council has tentative plans for centrifugal pumping equipment for proposed waterworks, for which bonds for $100,000, are being arranged.

Mo., Humansville—The West Missouri Light & Power Co. has acquired the steam power plant of the Sac River Light & Power Co., and plans for extensions and improvements in the station and system to cost $175,000, with equipment.

Mo., Poplar Bluff—The Bimmel-Ashcroft Mfg. Co. is said to be planning for a boiler house in connection with the rebuilding of the portion of its spoke and handle manufacturing plant, recently burned, with loss of $40,000.

Mo., St. Louis—The Highland Dairy Farms Co., 4816 Delmar Blvd., is said to have plans for a boiler house at its new distributing plant on Chouteau St., near Boyle Ave. The entire project will cost $200,000. Neal C. Davis, Central National Bank Bldg., architect.

Neb., Grand Island—The Central Power Co. has issued bonds for $1,500,000, a portion to be used for extensions and improvements in plant and system.

N. Y., Amsterdam—The Adirondack Power & Light Corp., Schenectady, N. Y., is disposing of a bond issue of $5,000,000, a portion of the proceeds to be used for expansion, including the completion of the steam generating plant addition, near Amsterdam, to increase the capacity 30,000 kw., scheduled to be ready for service at the end of the year. Charles S. Ruffner is first vice-president and general manager.

N. Y., Brooklyn—A steam power house, ice and refrigerating plant will be installed in the proposed municipal market to be erected on the site of the present Wallabout Market, Wallabout Basin, to cost $5,000,000. The Board of Estimate has approved an appropriation of this amount. The Department of Plant and Structures, Municipal Building, New York, Grover A. Whalen, commissioner, is in charge.

N. Y., Buffalo—The Standard Oil Co. has filed plans for a pumping plant at 1103 Elk St.

N. Y., Buffalo—The Webster Citizens Ice Co. has been granted permission to construct an ice-manufacturing plant at Cordova St. and Lasalle Ave., and will break ground at an early date.

N. Y., Gloversville—The United States Feldspar Co., C. H. Peddrick, Jr., 170 Broadway, New York, head, is said to be planning for a boiler house at its commercial feldspar works. The entire plant will cost $150,000.

N. C., Burlington—The North Carolina Public Service Co., Greensboro, N. C., has acquired the plant and property of the Piedmont Power & Light Co., and plans for extensions and betterments, including additional equipment.

Ohio, Cincinnati—The H. H. Meyer Packing Co. has had plans prepared for an addition to its cold storage plant at Linn St., and Central Ave., and will begin work soon. Tietig & Lee, Merchants Bldg., architects.

Ohio, Defiance—The Toledo Edison Co., Toledo, is perfecting arrangements for the purchase of the Defiance Gas & Electric Co.; the Swanton Light & Power Co., Swanton; and the Holgate Light & Power Co., Holgate, for a total consideration stated at $4,000,000. The new owner will merge the property and plans for extensions and improvements, including additional equipment.

Okla., Oklahoma City—The Oklahoma Gas & Electric Co. is issuing bonds for $2,000,000, a portion of the fund to be used for extensions and improvements.

Pa., Fleetwood—The Common Council is reported to be considering the erection of a municipal electric power plant. Estimates of cost will be secured in the near future.

Pa., Philadelphia—The Bureau of Supplies and Accounts, Navy Department, Washington, D. C., will take bids until June 24, for 100 strainer pumps for use at the local navy yard, as per Schedule 2305.

Pa., Philadelphia—The Board of Trustees, Girard College, Girard and Corinthian Sts., plans for a new mechanical school at the institution, to include a department equipped for the study of steam engineering. The project will be carried out in connection with an additional endowment fund of $1,000,000, now being obtained. John T. Windrim, Commonwealth Bldg., architect.

Pa., Philadelphia—The Board of Trustees, Masonic Home for Crippled Children, is having plans drawn for a steam power house and mechanical laundry at the new institutional building at Rhawn St. and the Roosevelt Blvd. The entire project will cost $500,000. Philip H. Johnson, 1713 Sansom St., architect.

Pa., Philadelphia—The Board of Public Works, City Hall, has awarded a general building contract to the Kober Construction Co., 34 South Seventeenth St., for a steam power house and heating plant at Wheatsheaf Lane and Richmond St., for municipal service, to cost $87,000, including equipment.

Pa., Pittsburgh—The Philadelphia Co., 435 Sixth Ave., operating utility properties, is said to be planning for steam power and pumping equipment in its eight-story and basement service building, at Sixth Ave. and Cherry Way, to cost $1,000,000. Ralph Rainsford is company steam and electrical engineer.

Pa., Pittsburgh—The Harmony Creamery Co., 407 Liberty St., is reported to be planning a boiler house in connection with its plant on property recently acquired at Lynn Way and North Murtland Ave., estimated to cost $150,000.

Pa., Pittsburgh—The Pittsburgh Hotels Co., William Penn Hotel, plans for additional steam-power equipment and pumping machinery for its addition, at Sixth St. and Grant Ave., estimated to cost $6,000,000. Benno Janssen, Century Bldg., architect.

R. I., Providence—The Atlantic Refining Co., 260 South Broad St., Philadelphia, Pa., is said to be planning for a pumping plant at its oil refinery in the Fuller Rock harbor section, on which work will soon proceed. Application has been made for the building of a wharf.

R. I., Providence—The Board of Trustees, Mary C. Wheeler School, is considering a boiler plant for heating service at the institution, in connection with additional buildings to cost $100,000. Frank L. Hinckley, president.

S. C., Westminster—The Common Council plans for centrifugal pumping equipment in connection with proposed extensions and improvements in the municipal waterworks and sewerage system. Bonds for $100,000, are being sold.

S. D., Sioux Falls—The City Council is having plans drawn for an addition to the municipal pumping plant, and will soon take bids. Joseph Schwarz, Minnehaha Bldg., architect. Walter Leyse is city clerk.

Tenn., Jackson—The Board of City Commissioners is taking bids until June 24, for one horizontal triple expansion condensing crank and flywheel pumping engine, capacity 6 m.g.p.d.; also, for one horizontal cross compound condensing crank and flywheel pumping engine, same rating. Samuel C. Lancaster, consulting engineer.

Tex., Brownsville—The Desel-Boettcher Co. will break ground at once for a cold storage plant, to cost $30,000. It is understood that a portion of the equipment has been purchased and that other apparatus will be ordered at an early date.

Tex., Crawford—The Common Council has preliminary plans for a municipal electric light and power plant. It is purposed to arrange a bond issue soon.

Tex., Eagle Lake—The Industrial Cotton Mills, Inc., recently formed with a capital of $1,000,000, plan for a steam-electric power plant at its mills. The complete project will involve $360,000. W. E. Lenhart, president. Benjamin H. Faber, architect.

Tex., Fort Worth—The Worth Mills, Inc., recently formed with a capital of $1,132,000, plan for a steam power plant for its cotton mill, to cost $750,000, complete. The company is headed by Charles L. Harding, Lloyd H. McKee, 1501 Cooper St., and associates. Charles T. Main, 200 Devonshire St., Boston, Mass., is architect and engineer.

Tex., Greenville—The Greenville Gin Co. plans for a boiler plant at its cotton gin, for steam service for gin operation. J. A. McSpadden is manager.

Tex., Houston—The Houston Textile Mills, Inc., has filed plans for a steam power plant at its new cotton mill. The entire project will cost $500,000. J. E. Sirrine & Co., Greenville, S. C., engineers.

Tex., Lufkin—The Texas Public Utilities Co., Dallas, is reported to be planning for extensions and betterments in the steam power plant and system of the Lufkin Electric Light & Power Co., recently acquired.

Tex., Slaton—The Common Council is considering centrifugal pumping equipment in connection with extensions and improvements in the waterworks to cost $60,000. Bonds have been approved.

Tex., Weatherford—The Milmo Lumber Co. is said to be planning for a boiler plant at its lumber mill, the entire project to cost $100,000, with equipment.

Tex., Wichita Falls—The State Board of Control, J. P. Greenwood, consulting engineer, is in the market for a watertube boiler and auxiliary apparatus, with total of about 2,000 sq.ft. of heating surface.

Vt., Winooski—Brewer & Co., Inc., Worcester, Mass., is reported to be planning for a boiler house for its new line plant now in course of building at Winooski, near Burlington; the entire project will cost $100,000.

Wash., Markham—The Mackie Lumber Co. contemplates a boiler plant in connection with the rebuilding of its local mill, recently partially burned with loss of $65,000.

Wash., Port Angeles—The City Council plans for centrifugal pumping equipment in connection with the proposed acquisition of the waterworks, and extensions and improvements. A special election has been called on July 12 to vote bonds for $625,000. The Burns & McDonnell Engineering Co., Marsh-Strong Bldg., Los Angeles, Calif., engineer.

Wash., Spokane—The Union Oil Co. of California, Los Angeles, has filed plans for a boiler plant and pumping plant at its mechanical and distributing works.

Wash., Tacoma—The Municipal Light Department will take bids soon for the power plant on the North Fork of the Skokomish River, in connection with the Cushman Lake municipal power project. It will cost about $250,000, with equipment. J. L. Stannard, chief engineer.

W. Va., Cedar Grove—The Tompkins Fuel Co., Charleston National Bank Bldg., Charleston, W. Va., has tentative plans for a motor-generator set and auxiliary equipment. Haulage motors and other heavy electric power apparatus will be installed at the mines. Harold Tompkins, president.

Wis., Menasha—The City Council has authorized an appropriation of $20,000, for extensions and improvements in its municipal electric lighting plant and waterworks. John F. DeGaro, city clerk.